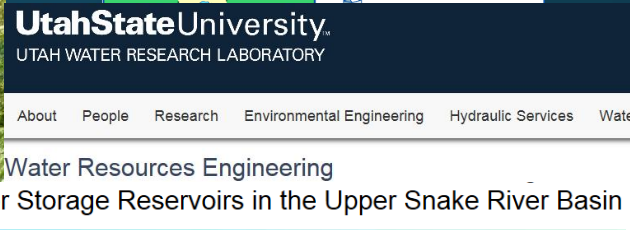
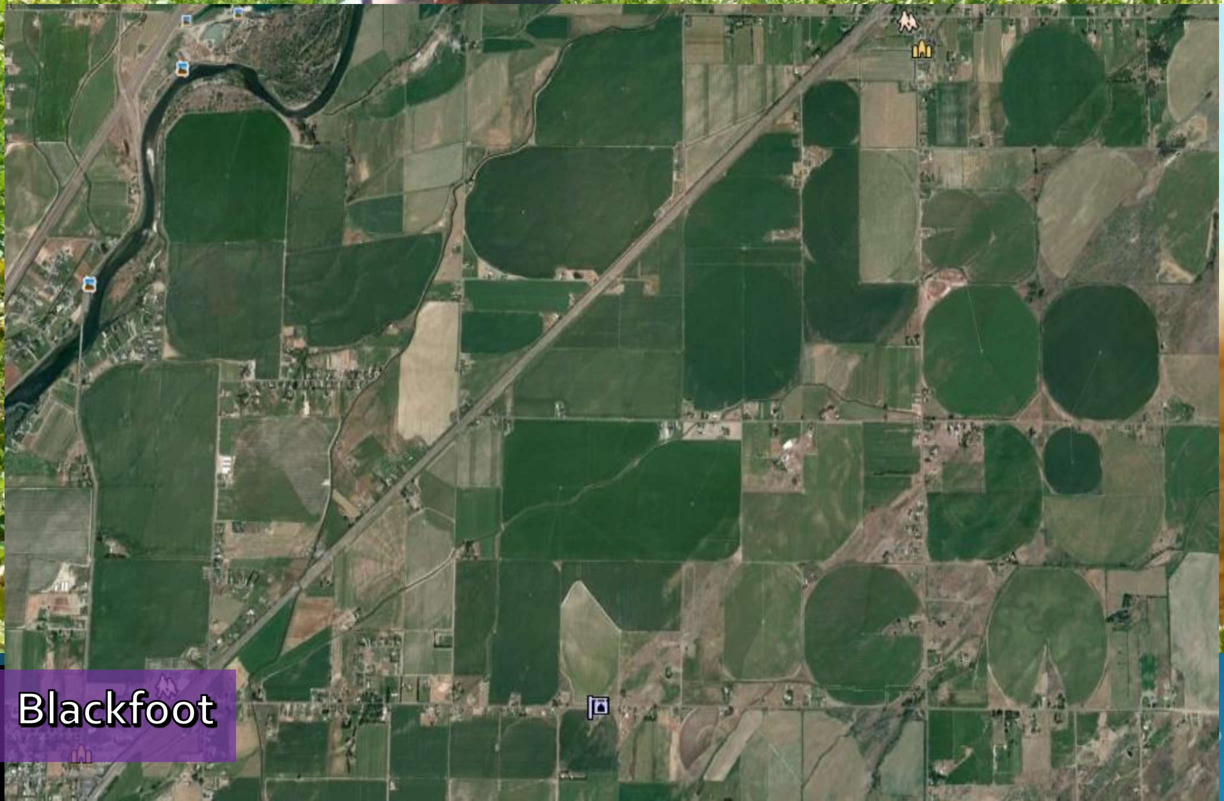
United States Department of Agriculture

Irrigation System Operation

Advice from a farmer and NRCS Engineer





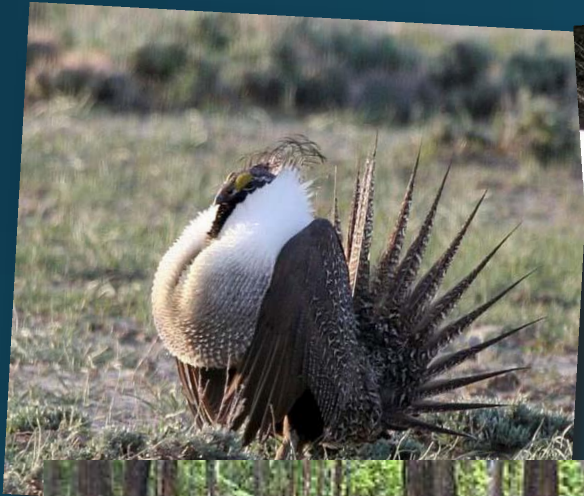
rvation Success

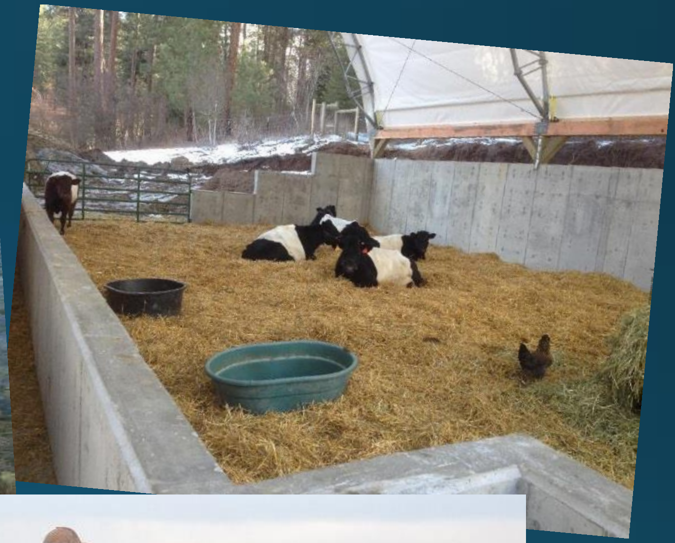
United States Department of Agriculture

Irrigation System Operation

Advice from a farmer and NRCS Engineer

Natural Resources Conservation Service





Funding Conservation Success

Irrigation System Operation
Advice from a farmer and NRCS Engineer

- Irrigation Water Management (hydraulic loading)
- Some Nutrient Management (constituent loading)
- A little on salinity

Irrigation Water Management
(Hydraulic Loading)

A note before we begin

- Start w IWM and an assumption of a Hydraulic Limiting scenario.
- this makes sense because if you don't get IWM and irrigation scheduling right, you're almost always getting the nutrient/constituent side wrong also.
  - ✓ typical thing here is wasting plant nutrients by losing them out of the root zone via deep percolation
  - ✓ bad economics
  - ✓ bad from a resources perspective because it increases risk that ground or surface water quality will be negatively impacted

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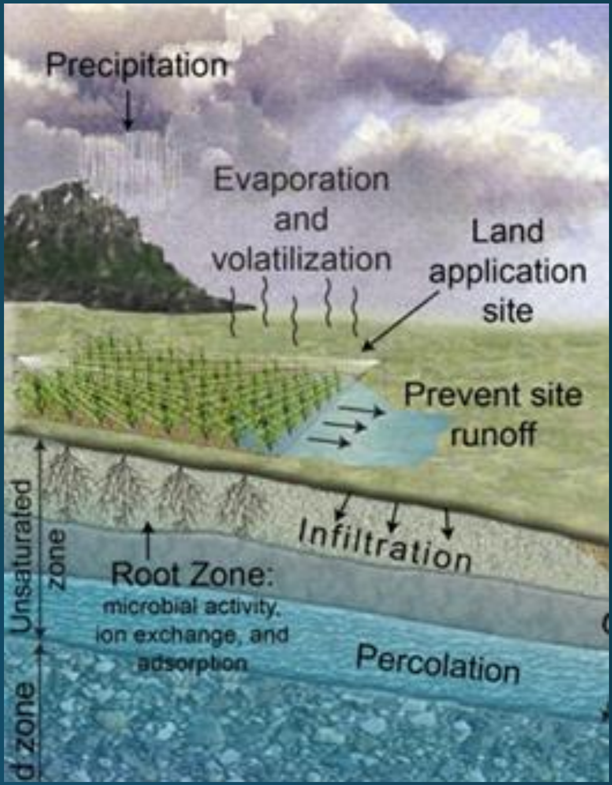
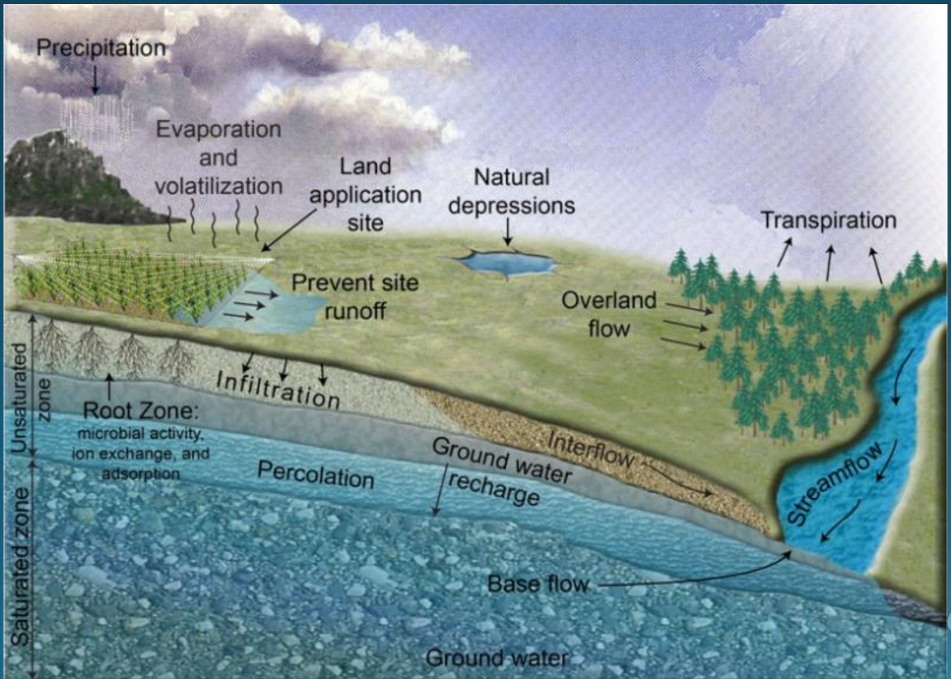
Hydraulic loading rate



- *Hydraulic loading rate* is the combination of all water (rain water, wastewater, and irrigation water) applied to a land application site.

Hydraulic loading rate limits

- Idaho DEQ reuse permits specify hydraulic loading rate limits for *growing season* and *non-growing season*:
  - growing season identified by climatic conditions. Typical = April 1 - October 31
  - typical non-growing season dates = November 1 - March 31



Irrigation Water Management

(Hydraulic Loading)

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Step 1. Have a plan
- annual loading
- how to execute on a daily basis

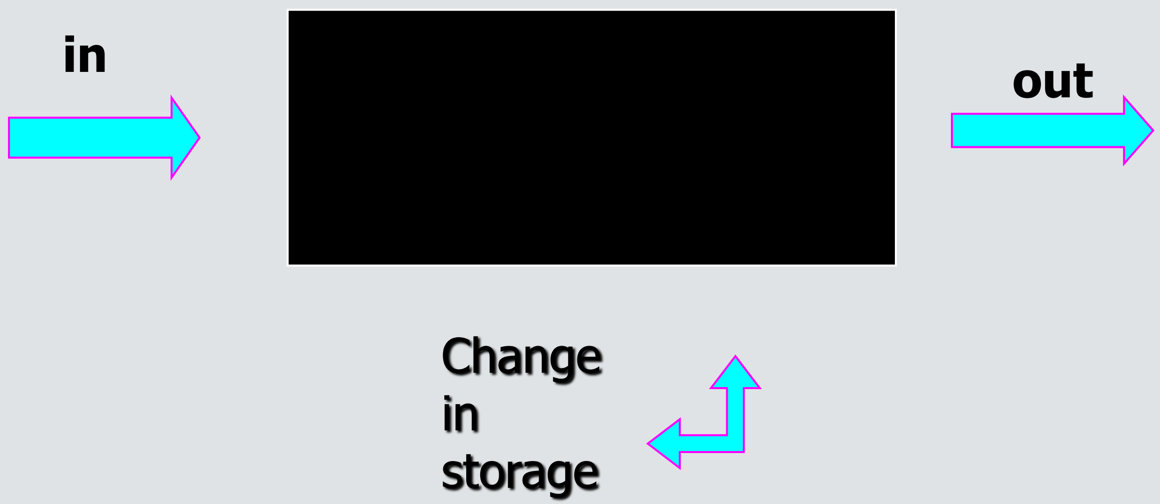
Step 2. Begin executing the plan

Step 3. Adjust……change course based on
- actual hydraulic loading
  - ✓ actual irrigation system performance
  - ✓ actual rain and/or ground water contribution
- actual climatic conditions and crop performance
  - ✓ disease
  - ✓ insect/pest
  - ✓ weather like frost, wind, heat, etc
  - ✓ Sufficient water & nutrients?
- actual (calculated) evapotranspiration

Step 4. Measure soil moisture, calibrate and reset

Step 1. The Plan. It should be based on a Mass Balance

$$\text{In} - \text{Out} = \Delta\text{Storage}$$

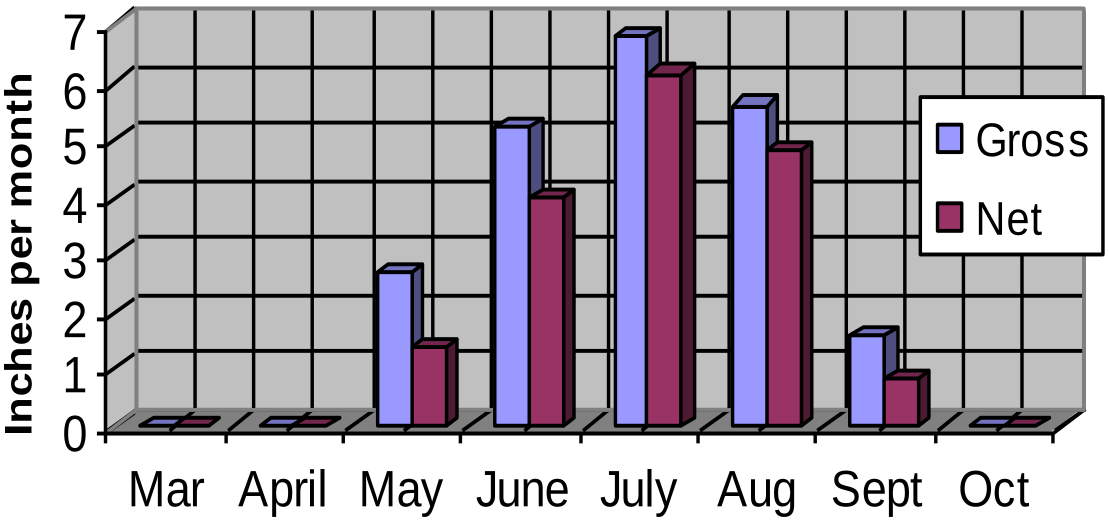


? – for a yearly time step, what is a good assumption for Δstorage

Annual basis

Table 4-5 Estimated Seasonal and Monthly Consumptive Use of Crops for Climatic Zone 1A

CUCUMBERS



		GROSS	NET
Spring date	May 10	2.66	1.35
	June	5.22	3.97
	July	6.82	6.15
	August	5.59	4.81
Fall Date	Sept. 20	1.58	0.80
	Seasonal Totals	21.87”	17.08”

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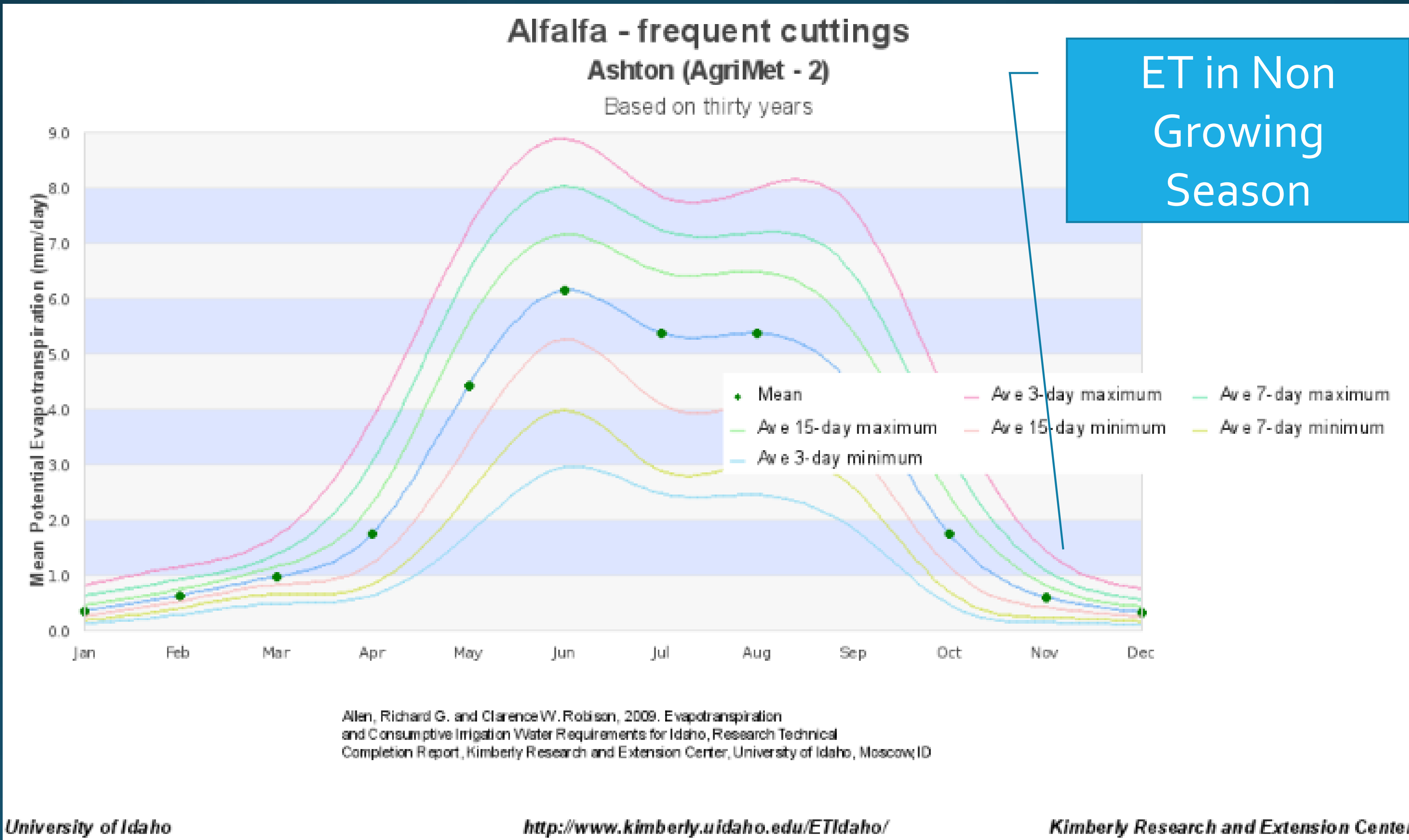
Annual basis

Growing Season[a]	Non Growing Season[b]	Annual
mm		
837	144	981

ET in Non Growing Season



Irrigation Water Management

(Hydraulic Loading)

Average growing season ET for a healthy crop	
Alfalfa grass	31 inches
Sugar beets	28 inches
Grass pasture	26 inches
Silage corn	21 inches

annual loading analysis can help with crop selection

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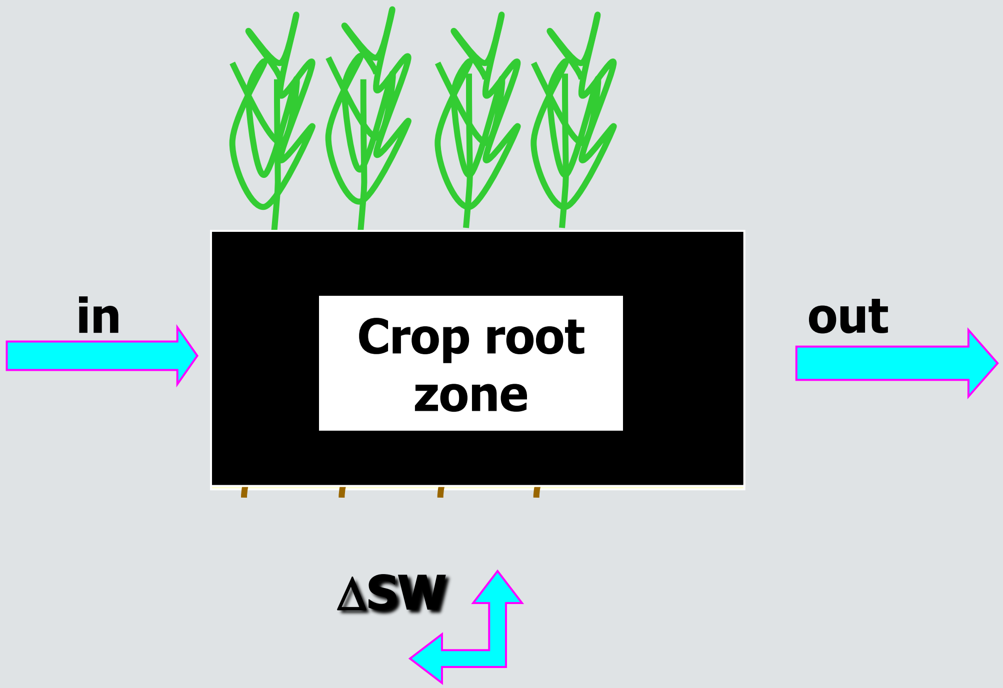
Irrigation Water Management

(Hydraulic Loading)

Step 2. Execute on a daily basis

- must know more about the black box (the root zone).....
- and what's coming in and going out.....
- so we can decide how much and when to irrigate

Daily Water Balance in the Root Zone



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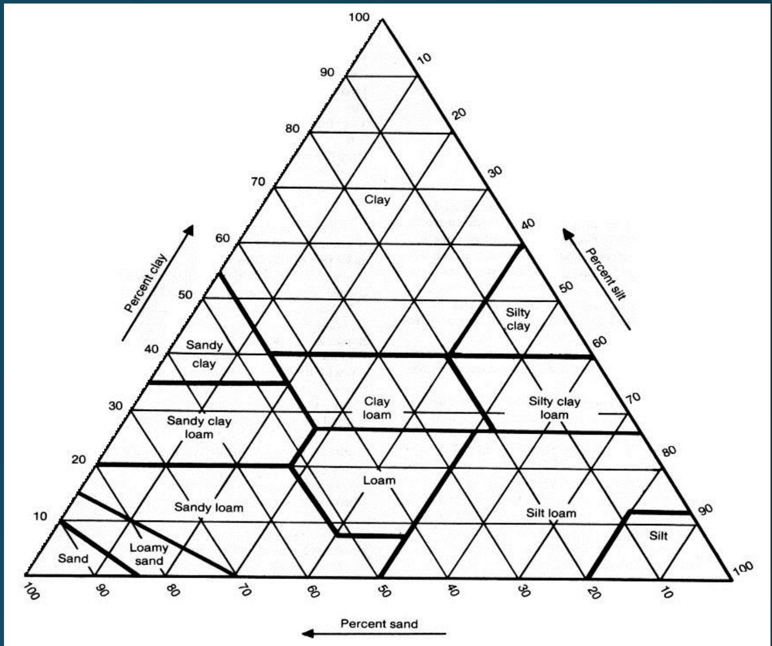
The Root Zone



SOIL

- storehouse of plant nutrients
- anchor for roots
- RESERVOIR FOR HOLDING WATER
  - ✓ Need to get the water into the soil
  - ✓ Need to know how much it can hold

The Root Zone

For Irrigation Purposes

- almost always talk of soil and soil-water in terms of depth
  - ✓ Soil depth is 30”
  - ✓ Soil will hold 6” of water
- Also talk of soil water in terms of % (by volume)
- For water, we normally don’t talk in terms of mass or weight

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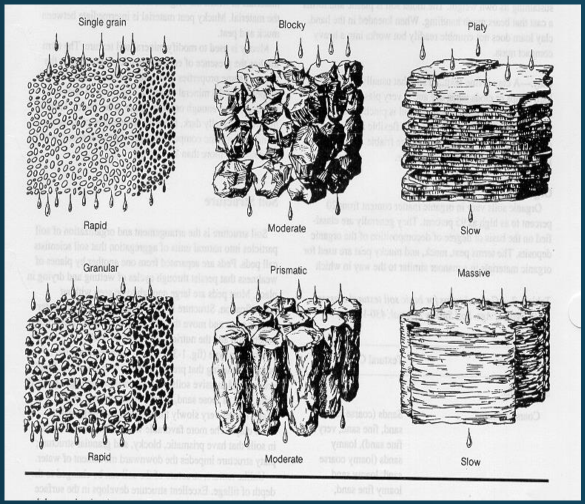
The Root Zone



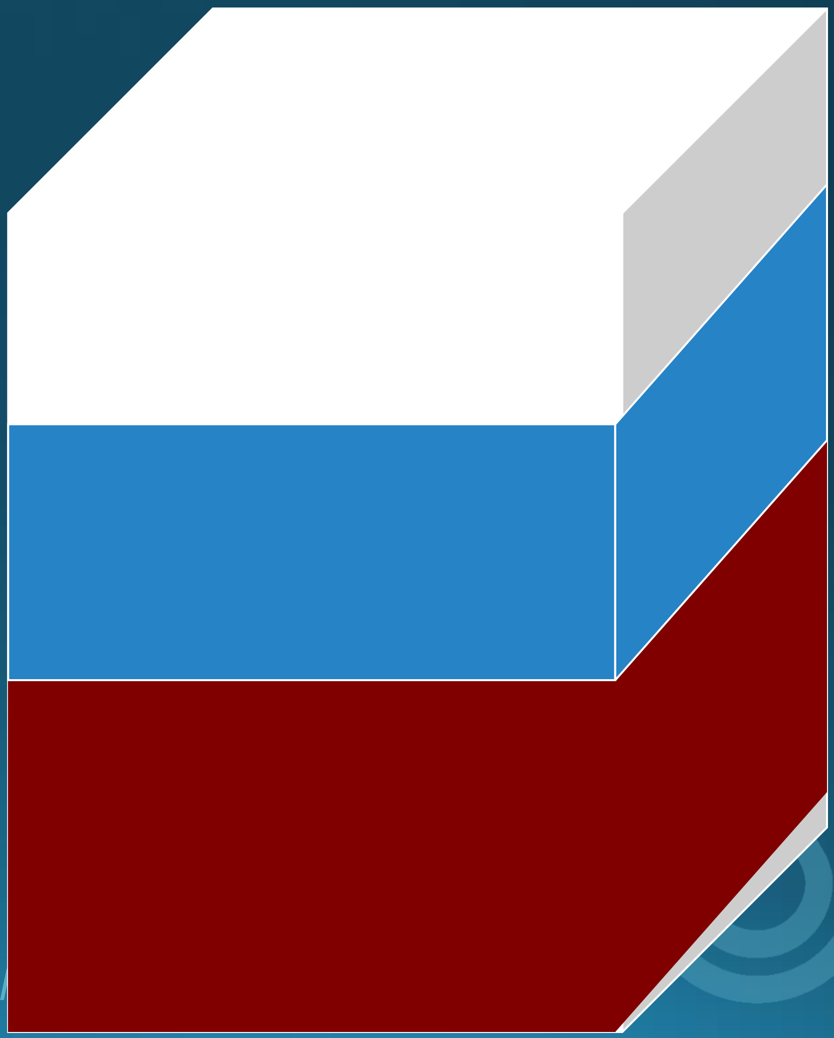
A Typical Volume of Soil

Pore Space

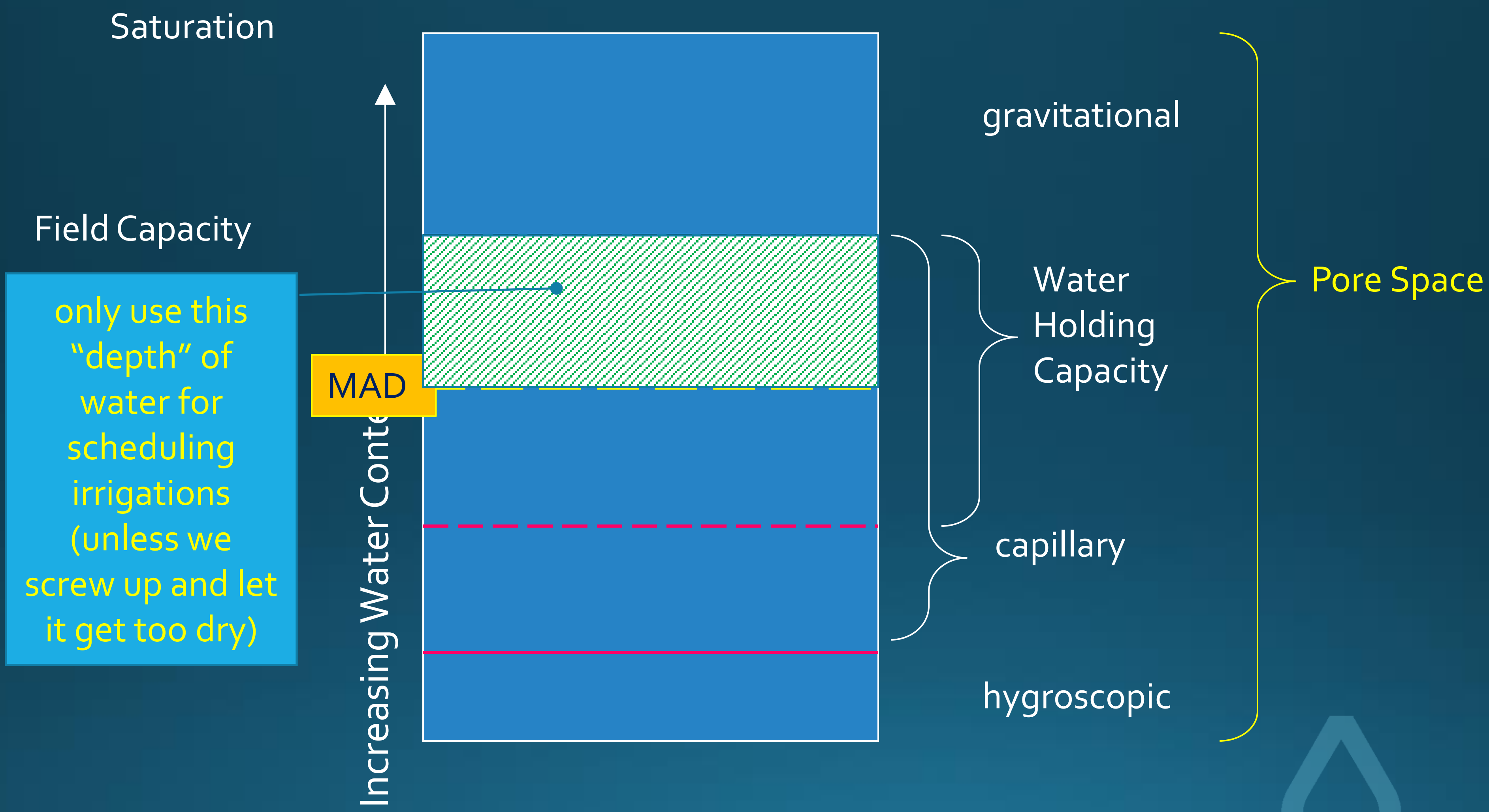
Air

Water

Solids



Soil-Water Terms Illustrated



The Root Zone

MAD

- Management Allowable Depletion
- Expressed as % of the Water Holding Capacity
- For many crops, it varies with stage of growth
- Ideally irrigation is started right before MAD is reached
- A little bit like a safety factor (for the engineers)

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The Root Zone

So what's a typical maximum application depth based on 2nd year alfalfa in a fine sandy loam? In other words, if you let soil moisture get depleted to the point of MAD, how much should you apply?

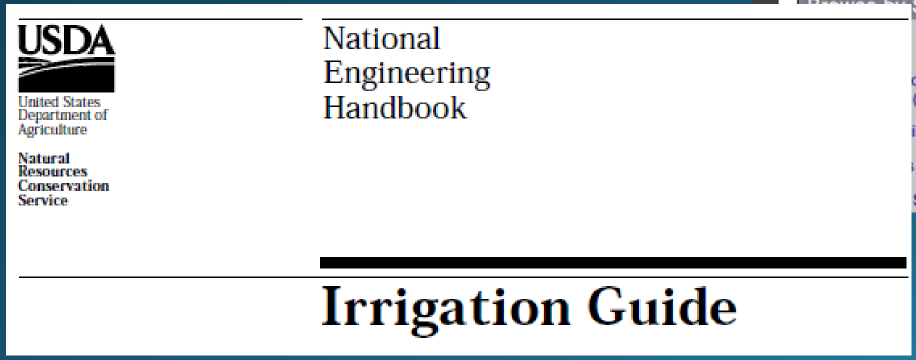
- Root zone for IWM purposes about 4 feet
- Water holding capacity about 15% (or about 1.8 inches per foot)
- Let's use MAD of 60%

$$4\ feet\ * \left(12\frac{inches}{ft}\right) *\ 0.15\ * 0.60 = 4.3\ inches$$

The Root Zone

Sources for soils and crop data like rooting depth, water holding capacity, wilting point, and MAD

- ❑ Labs & Consultants, Universities, State agencies…
- ❑ NRCS
  - local office staff
  - Irrigation Guide
  - Web Soil Survey



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Natural Resources Conservation Service

National Engineering Handbook

Irrigation Guide

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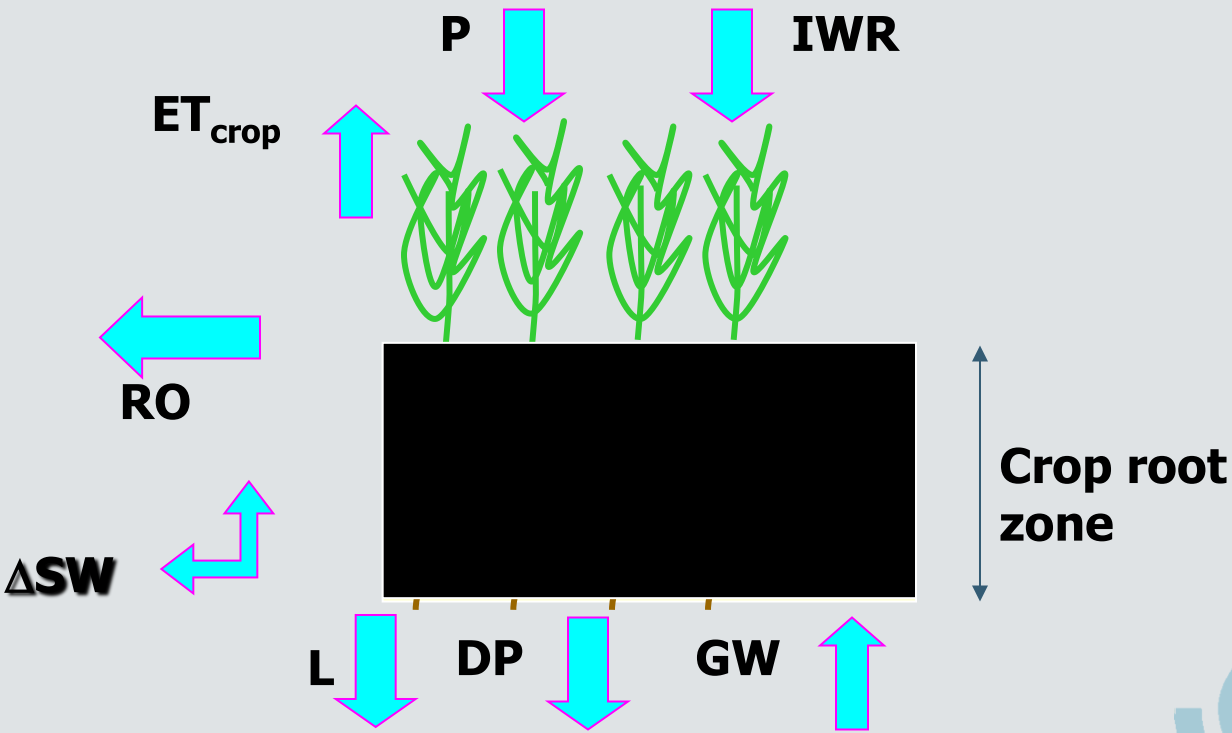
Back to Step 2, Executing on a Daily Basis…..a closer look at what's coming in and going out of the root zone

$$IWR = ET_{crop} + DP + RO - P \pm \Delta SW - GW + L$$



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in & out

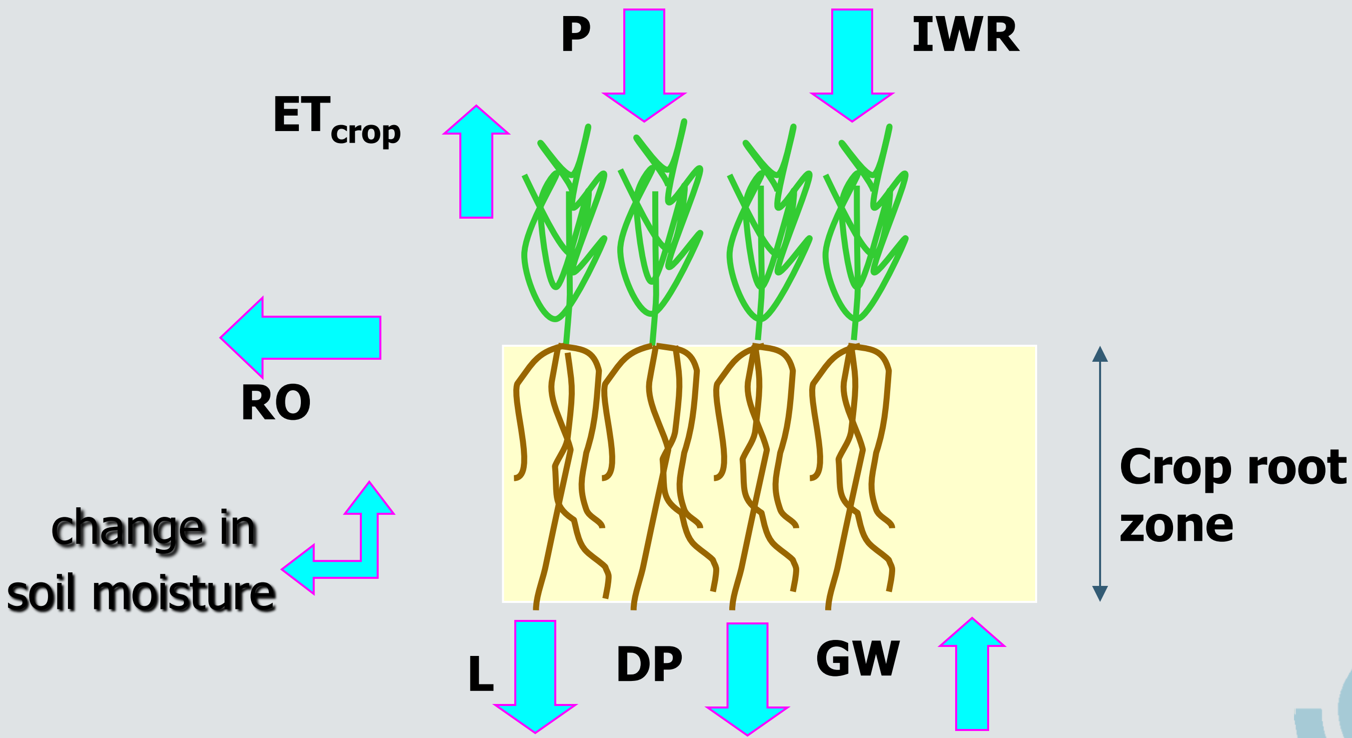
Going in

- Precipitation
- Ground water
- Irrigation Water Requirement

Going out

- Evapotranspiration
- Runoff
- Deep Percolation
- Leaching Requirement

$$IWR = ET_{crop} + DP + RO - P \pm \Delta SW - GW + L$$



in & out

Precipitation

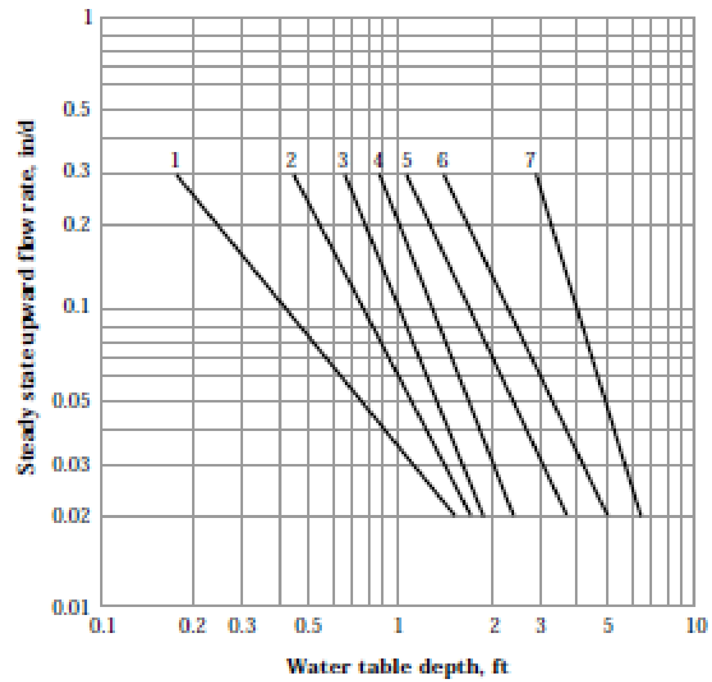
- Rain gauges
- Weather stations

Estimate Groundwater with

- Depth to water table
- Soil type

Figure 2–6 Water table contribution to irrigation requirement, as a function of soil type (texture) and water table depth

Soil type	Line number
Sticky clay	1
Loamy sand	2
Clay	3
Peat	4
Clay loam	5
Sandy loam	6
Fine sandy loam	7



in & out

Runoff is bad

- Irrigation system uniformity is not as assumed
- Risk to water quality goes up
- NRCS Idaho can provide some advice

Deep Percolation is bad

- Risk to water quality goes up

Leaching may be required for crop production but…

- Risk to water quality goes up

ET for irrigation scheduling

- Various ways & sources
- AgriMet an excellent source

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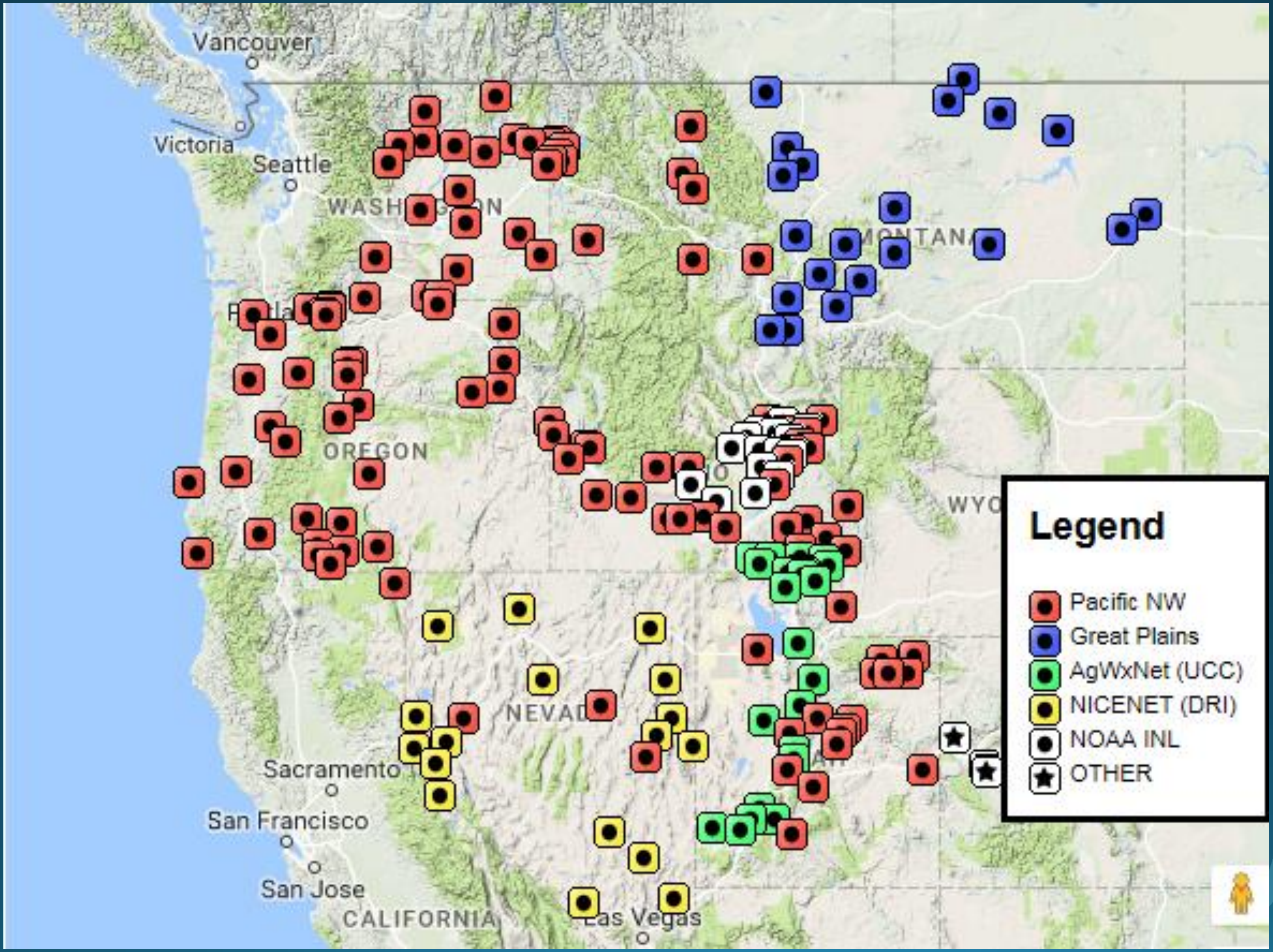
in & out

The AgriMet System



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in & out

The AgriMet System

ESTIMATED CROP WATER USE - May 15, 2017 TWFI

CROP	START DATE	DAILY CROP WATER USE-(IN) PENMAN ET - May 11	12	13	14	DAILY FORE CAST	COVER DATE	TERM DATE	SUM ET	7 DAY USE	14 DAY USE
ETr	03/10	0.32	0.28	0.18	0.18	0.21	03/10	10/10	11.1	1.7	3.3
ALFP	03/20	0.32	0.28	0.18	0.18	0.21	05/20	10/10	7.1	1.7	3.3
ALFM	03/20	0.27	0.24	0.15	0.15	0.18	05/20	10/10	6.5	1.4	2.8
ALFN	03/20	0.32	0.28	0.18	0.18	0.21	05/20	10/10	7.1	1.7	3.3
PAST	03/15	0.22	0.19	0.12	0.12	0.15	05/10	10/10	5.9	1.1	2.2
LAWN	03/15	0.26	0.22	0.14	0.14	0.17	05/01	10/10	7.2	1.4	2.6
WGRN	03/10	0.32	0.28	0.18	0.18	0.21	05/25	07/20	8.9	1.7	3.3
SGRN	04/01	0.29	0.26	0.17	0.17	0.20	06/25	08/01	4.5	1.5	2.8
SGRN	04/15	0.21	0.19	0.13	0.13	0.15	07/05	08/10	2.3	1.1	1.7

Irrigation Water Management

(Hydraulic Loading)

in & **out**

Irrigation Water Applied

- *Irrigation rate* is normally expressed as unit depth of water (inch) per unit of time, (usually an hour). *NOTE: This is really a flow rate – volume of water per unit time, like MGD. It's just simplified by assuming the area over which the water is applied*
- *Total application depth* (inch), which is computed based on the amount of time the system operates at a given rate on a given field. *NOTE: This is really a volume of water: depth x area.*

in & out

Irrigation Water Applied

- for stationary sprinklers (hand lines, wheel lines, solid set)

- irrigation rate
  1. Find nozzle discharge rate and wetted diameter
  2. Use the nozzle spacing
  3. Compute irrigation rate

$$\text{Irrigation rate (in/hr)} = \frac{96.3 * \text{discharge rate (gpm)}}{\text{sprinkle spacing (ft)} * \text{lateral spacing (ft)}}$$

  4. Water applied – the application depth - is then simply the irrigation rate multiplied by the operating time

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in & out

Irrigation Water Applied

- Center Pivot and Linear Systems
  - Precipitation Chart gives application depth as % of maximum speed
  - Application rate varies from near the pivot point to the end, getting higher as it goes.
  - Typical maximum rates for Mid elevation spray systems are 2 inches per hour or greater

? Can you change the application rate of a pivot by adjusting its speed (changing the % timer)

PRECIPITATION CHART

WISHNW-

DEALER -

IRRIGATOR -

TOTAL LENGTH PIPE = 1306.47
GPM UNDER PIPE = 870.31
ACRES UNDER PIPE = 123.11
RANGE OF ENDGUN = 82.41
GPM OF ENDGUN = 129.88
ACRES UNDER ENDGUN = 16.02

SYSTEM PRESSURE = 60 PSI
TOTAL GPM = 1000.19

MOTOR SIZE (HP) = 3/4
LOADED MOTOR RPM = 1750
CENTER GEAR BOX RATIO = 40
WHEEL GEAR BOX RATIO = 50
TIRE SIZE = 14.9 X 24
LAST TOWER SPEED (FPM) = 10.20

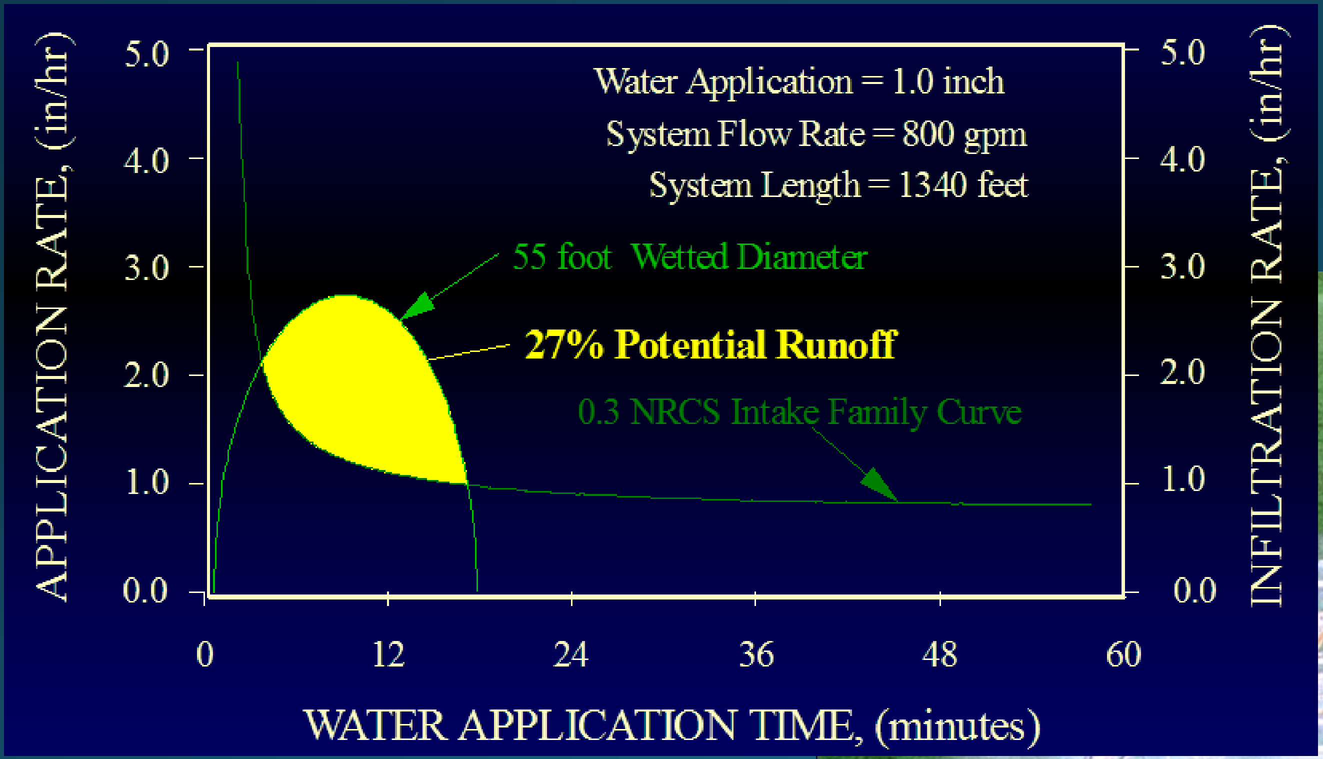
PRECIPITATION DATA FIGURED WITH ENDGUN RUNNING

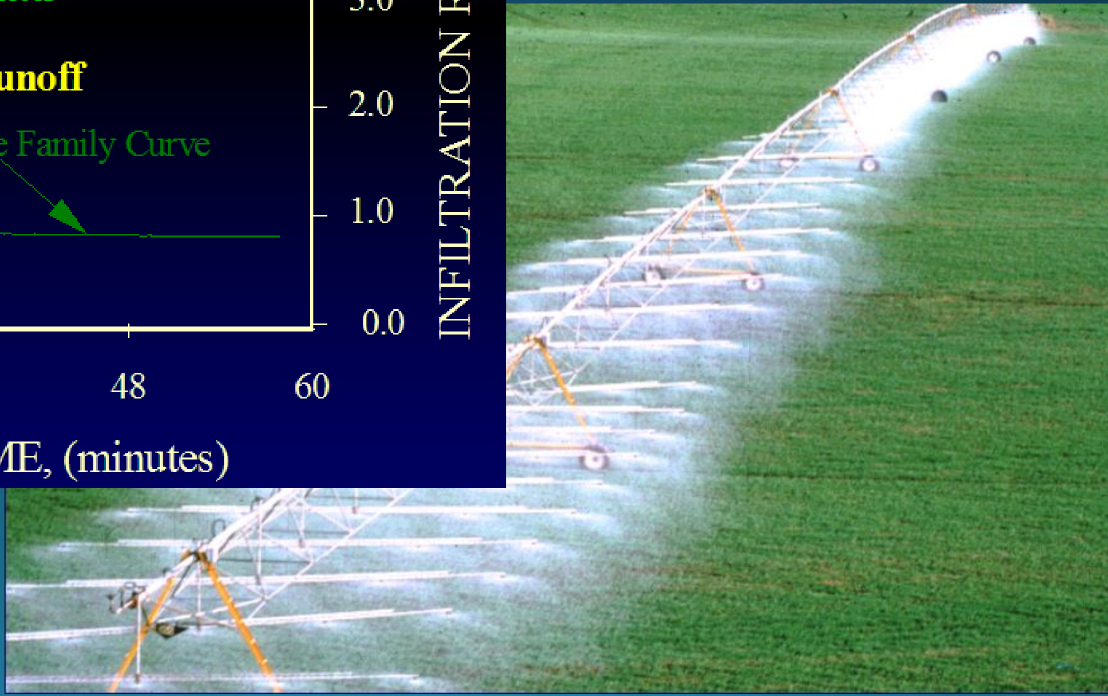
PRECIPITATION BASED			% TIMER BASED		
PRECIPITATION INCHES	% TIMER SETTING	TIME HOURS	% TIMER SETTING	PRECIPITATION INCHES	TIME HOURS
.20	100.00	12.73	100.00	.20	12.73
.20	99.44	12.80	90.00	.22	14.15
.25	79.55	16.00	80.00	.25	15.91
.30	66.29	19.20	70.00	.28	18.19
.40	49.72	25.61	60.00	.33	21.22
.50	39.77	32.01	50.00	.40	25.46
.60	33.15	38.41	45.00	.44	28.29
.70	28.41	44.81	40.00	.50	31.83
.75	26.52	48.01	35.00	.57	36.37
.80	24.86	51.21	30.00	.66	42.44
.90	22.1	57.61	25.00	.80	50.92
1.00	19.89	64.01	20.00	.99	63.65
1.25	15.91	80.02	15.00	1.33	84.87
1.50	13.26	96.02	10.00	1.99	127.31
1.75	11.36	112.03	5.00	3.98	254.61

CAUTION: The relationship between precipitation rate, timer setting, and hours per revolution provided above are theoretical numbers based on the data list at the top of the page. Actual precipitation rates may vary due to the following field and machine conditions: wind drift; evaporation; tire slippage, tire loaded radius; drive train efficiency; elevation changes; soil type. Due to these varying field and machine conditions the above chart should be used as a guide only.

A couple thoughts on runoff

- Runoff decreases uniformity….which on a field basis leads to more unbalanced hydraulic loading, not just soil erosion.
- NRCS Idaho recommends an approach with
  - Hardware to minimize application rate : booms, type of sprinkler, etc
  - Management to maximize infiltration rate & surface storage: residue management (reduced or no-till), contour farming, reservoir tillage, etc





Irrigation Water Management

(Hydraulic Loading)

So how do we keep track of this Water Balance on a daily basis?

"Checkbook method"

Water is analogous to money
Root zone is the account
Soil moisture is the balance
Helps keep track of what goes in and what goes out
Irrigation is done when the soil-water content in the root zone reaches the MAD level

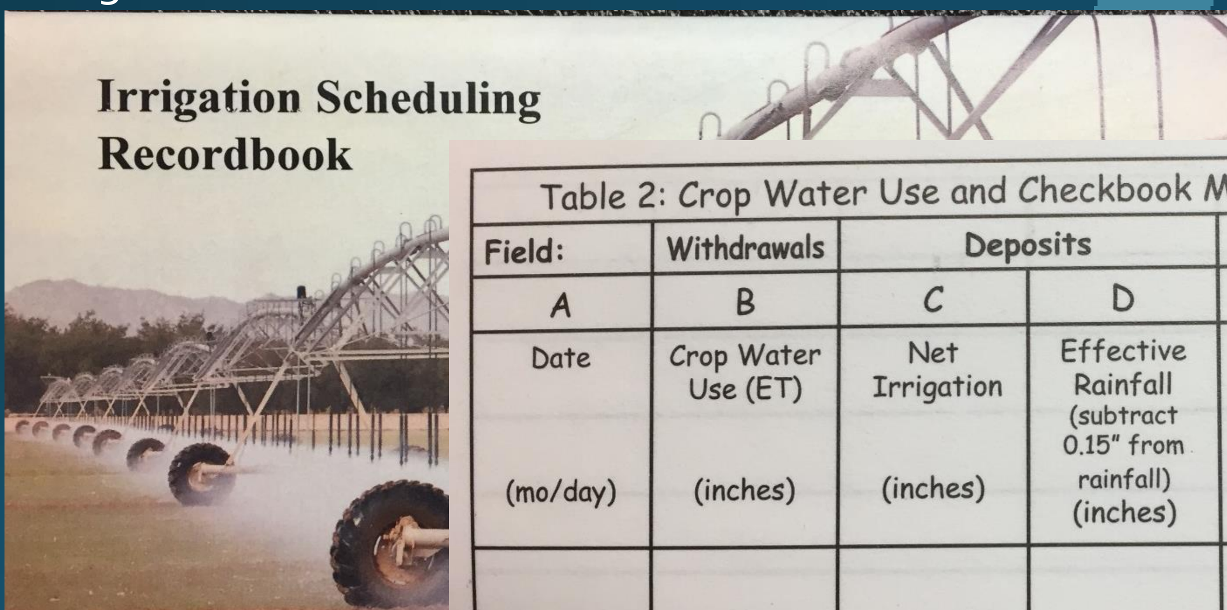
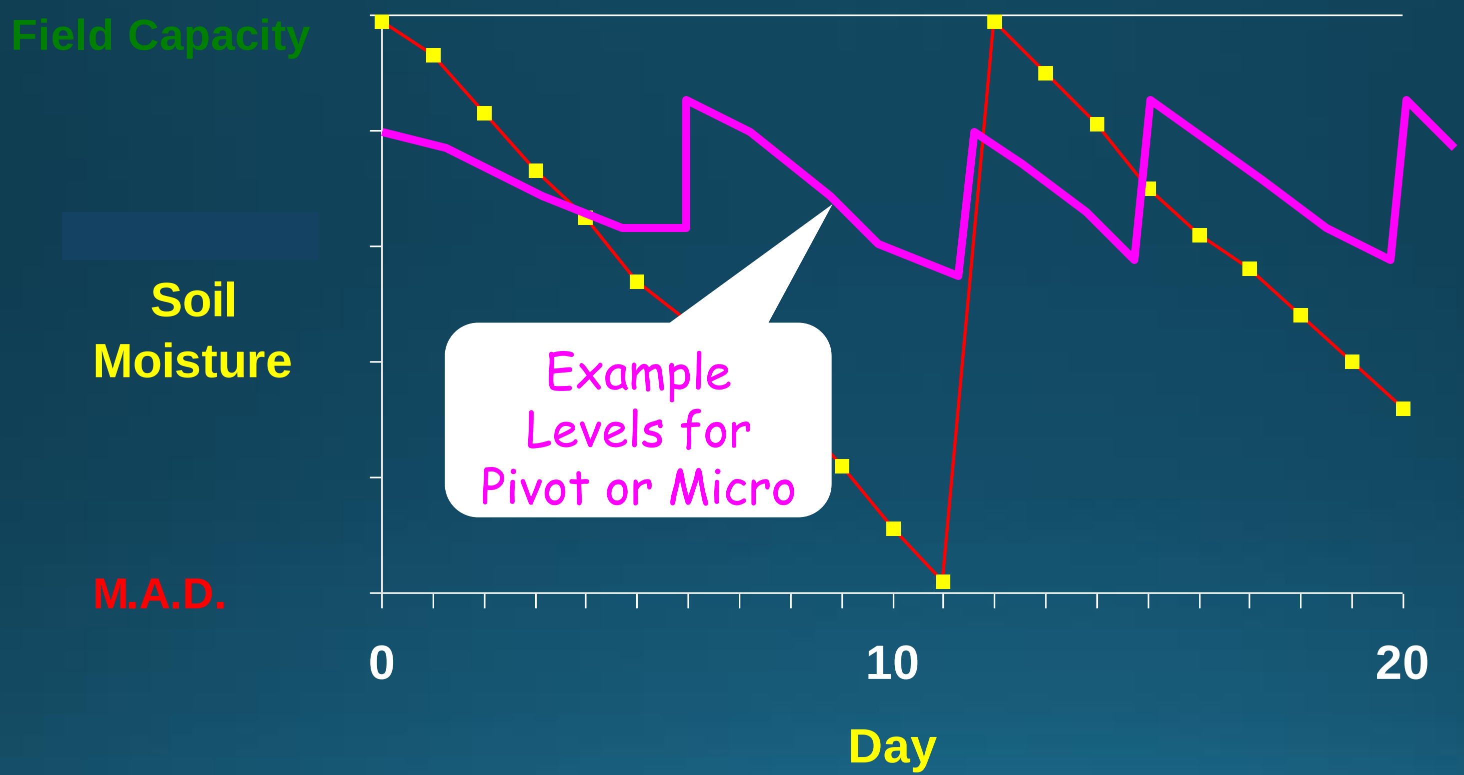


Table 2: Crop Water Use and Checkbook Method for Irrigation Scheduling					
Field:	Withdrawals	Deposits		Balance	Notes
A	B	C	D	E	F
Date (mo/day)	Crop Water Use (ET) (inches)	Net Irrigation (inches)	Effective Rainfall (subtract 0.15" from rainfall) (inches)	Available Soil Water Previous E - B + C + D (inches)	Minimum Balance ______ in. Observed/measured soil moisture level or depletion Date & amount of next irrigation

The USDA is an

Irrigation Scheduling:
Graph of the "Checkbook" Method



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Step 4. Check the soil and reset

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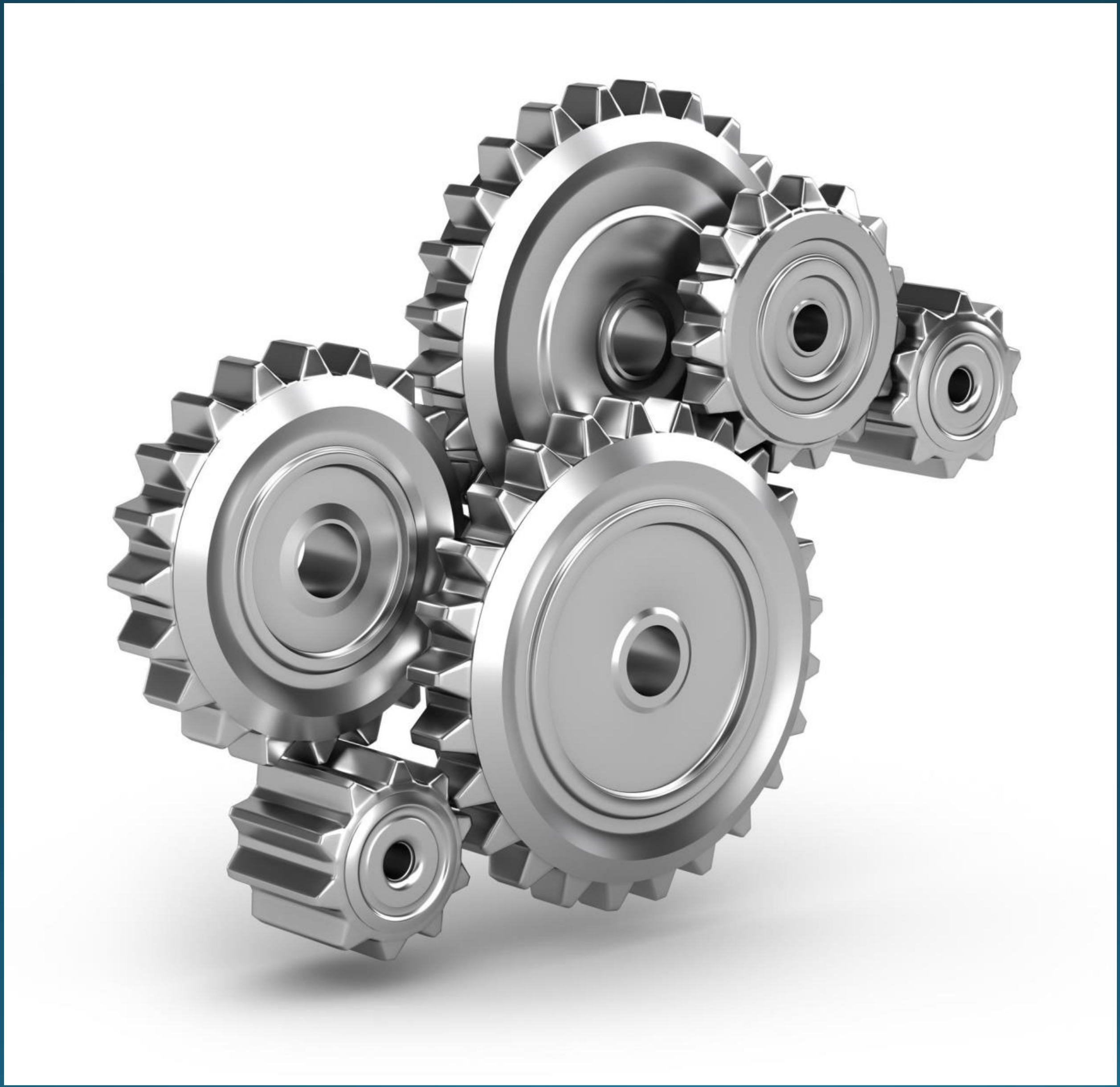

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Nutrient Management
(Constituent Loading)

Land limiting constituent

- Wastewater from most domestic and commercial sources contains low concentrations of nitrogen, phosphorus, COD, and other constituents, such as total dissolved solids.
  - for these sources, the site is limited by the hydraulic loading rate (*hydraulically limited)*, based on crop water requirements
- With higher strength wastewaters, amount of applied wastewater may be limited by the amount of nitrogen, phosphorus, or COD.
  - this *land limiting constituent* (LLC) dictates amount of wastewater that may be land applied. In these cases, sites typically use supplemental irrigation water to insure the crop is receiving adequate moisture for crop health.

Nutrient Management

(Constituent Loading)

My Farming Experience

- Mostly an annual process but, especially with potatoes, we did some in-season management (adjusting the original plan)
- Relied heavily on past experience
- Nitrogen the primary decision driver but P, K, and micronutrients also were considered
- Only sampled soil prior to potatoes. Fertilizer dealer “field man” would take the samples, get analysis done by a lab, then provide recommendation for commercial fertilizer. We often applied less.
- Later we’d have the field man gather “petioles” and adjust chemigation and/or have “foliars” applied

Nutrient Management
(Constituent Loading)

My NRCS Experience

- Mostly related to IWM
- Also "waste storage facilities"
  - ✓ Solids stacking, composting areas, etc
  - ✓ Liquid storage facilities, most often earthen ponds
  - ✓ These facilities require a Nutrient Management Plan
- Helped with the Idaho Nutrient Transport Risk Analysis
  - ✓ Nitrogen
  - ✓ Phosphorus
  - ✓ Surface waters
  - ✓ Ground waters
- Nutrient Management (Practice Standard 590)

"An annual nutrient budget for N, P, and K must be developed that considers all potential sources of nutrients including ...green manures, legumes, crop resides, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water."

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Idaho's 2013 590's Table 2. INTRA Risk Criteria for Fertilizer and Manure Applications

INTRA Index	Fertilizer and Manure Application Rate	Additional Mitigating Practices
LOW	P can exceed the crop rotation's P requirement. N rates can not exceed the N requirement for the crop grown following application.	Restrictions limited to mitigating INTRA Nitrogen leaching risk factors that score HIGH or VERY HIGH in the Ground Water Quality Risk Assessment evaluation.
MODERATE	P cannot exceed the rotation's crop P uptake rates. N rates can not exceed the N requirement for the crop grown following application.	Appropriate in-field Conservation Practices to control runoff/erosion (e.g. residue and tillage mgt) OR filtering practices (buffers) are needed to prevent off-site transport. The field must be prepared to prevent runoff from the field following application and prior to incorporation.
HIGH	P cannot exceed the rotation's crops P removal rates. N rates can not exceed the N requirement for the crop grown following application.	Appropriate in-field Conservation Practices to control runoff/erosion (e.g. residue and tillage mgt) AND filtering practices (buffer) are needed to prevent off-site transport. The field must have a mitigation plan to prevent runoff from leaving the field throughout the year. [1]

For any risk rating, N ≤ Crop N requirement

C. Phosphorus Risk Assessment Criteria.

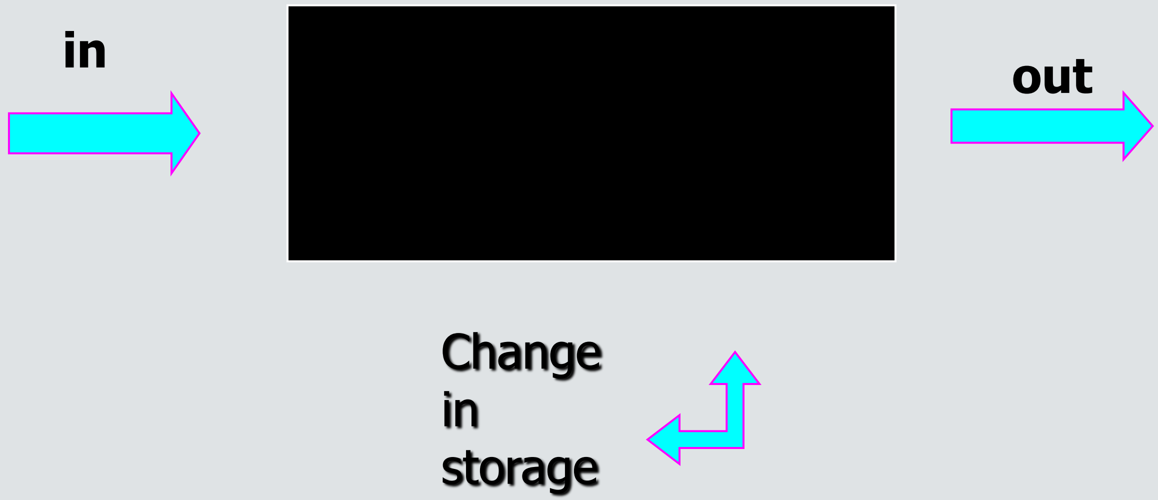
(1) P-Index Assessment Requirement. **INTRA:**

(vi) Include the following risk categories:

- » **Low risk** => **Crop P Requirement**
- » **Moderate risk** = **Crop P Uptake**
- » **High risk** =< **Crop P Removal**

- Mass Balance where whatever constituent you're considering is the mass
- And now the balance (concentration of constituent) in storage becomes a driving factor in many risk-based approaches to managing application of nutrients

$$\text{In} - \text{Out} = \Delta\text{Storage}$$



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Crop Nutrient Requirements

- Nutrients in Water
  - Level of nutrient availability in water affects plant growth and may impact ground water if not properly managed.
  - To maximize nutrient use, the WWLA operator should develop a *nutrient management plan*.
- *Typical crop uptake*: the numerically-median constituent crop uptake value from the 3 most recent, previous years the crop has been grown .
  - Domestic wastewater generally contains low concentrations of the major plant nutrients
  - Soil amendments (fertilizer) may be needed to meet crop demand.

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- As a farmer I had a Nutrient Management Plan (not an NRCS version ☺).
- I then set the injection pump to place fertilizer into the irrigation water at a known rate so I could add a target amount of "units" of N or P.
- This is exactly the same as knowing what nutrients are in reuse water!

Natural Resources Conservation Service

Developing a Basic Nutrient Budget

By: Travis Youngberg
NRCS State Agronomist

<u>Step 1</u>: Start With a Soil Test

Western Laboratories, Inc.
211 Highway 95 • P.O. Box 1020 • Parma, ID 83660
800-658-3858 • FAX 208-722-6550
http://www.westernlaboratories.com

Dealer: PD
Reported: 3-7-2012
Test #: 590B
Grower: Joe Farmer
Field ID: Field 1

PAP-Accredited NAPT 2011

Lab #: 23360

AGRICULTURAL SOIL REPORT

ELEMENT	ANSWER	INTERP	SHOULD BE	ELEMENT	ANSWER	INTERP	SHOULD BE
pH-Soil	7.9	Moderately Basic		Potassium-ppm	437	Adequate	300 +
pH-SMP				Potassium Bicarb	350	Medium	250 +
pH-CaCl	7.5			Sulfate-ppm			20 +
Soluble Salts	0.16	Normal	< 1.5	Calcium-ppm			1,800 +
% Lime				Magnesium-ppm			250 +
% Organic Matter	1.02	Very Low		Sodium-ppm			< 225
Nitrates-ppm	23	Adequate	10 - 35	Zinc-ppm			1.0 - 3.0
Ammonium-ppm	8	Adequate	5 +	Copper-ppm			0.8 - 2.5
Phosphorus-ppm	21	Low	25 - 40	Manganese-ppm			6 - 30
Phos-ppm-Bray			50 - 100	Iron-ppm			7 +
				Boron-ppm			0.7 - 1.5

		TBS%	P INDEX
Texture			
Cation Exchange Capacity - CEC		100	
Percent Base Saturation	?		

BASES	IDEAL	YOURS
Calcium-% of CEC	65-80	?
Magnesium-% of CEC	10-20	?
Potassium-% of CEC	2-6	?
Sodium-% of CEC	< 5	?
Hydrogen-% of CEC	< 15	

	NO3 ppm	NH4 ppm
1 Ft	15	5
2 Ft	8	3
3 Ft		
Total N PPM		31
Lbs N / Acre		93

Ratio	Ideal	Yours	Evaluation	Recommendations
Ca:Mg	6-20:1	:1		
Ca:P pH >7	100:1	0:1	OK	
Ca:P pH <7	40:1	:1		
P:Zn	15:1	?:1	High	Watch Zn

Fertilizer Suggestions In Pounds per Acre for the whole season

Crop	SWS Wheat	
Yield Goal	110 Bu.	
Past Crop	Fallow	
Acres	9	
Nitrogen	94	
Phosphate		
Add Phos for P INDEX		
Potash		
Sulfates		
Elemental Sulfur		
Gypsum		
Lime		
Dolomite		
Magnesium		
Zinc		
Manganese		
Copper		
Boron		

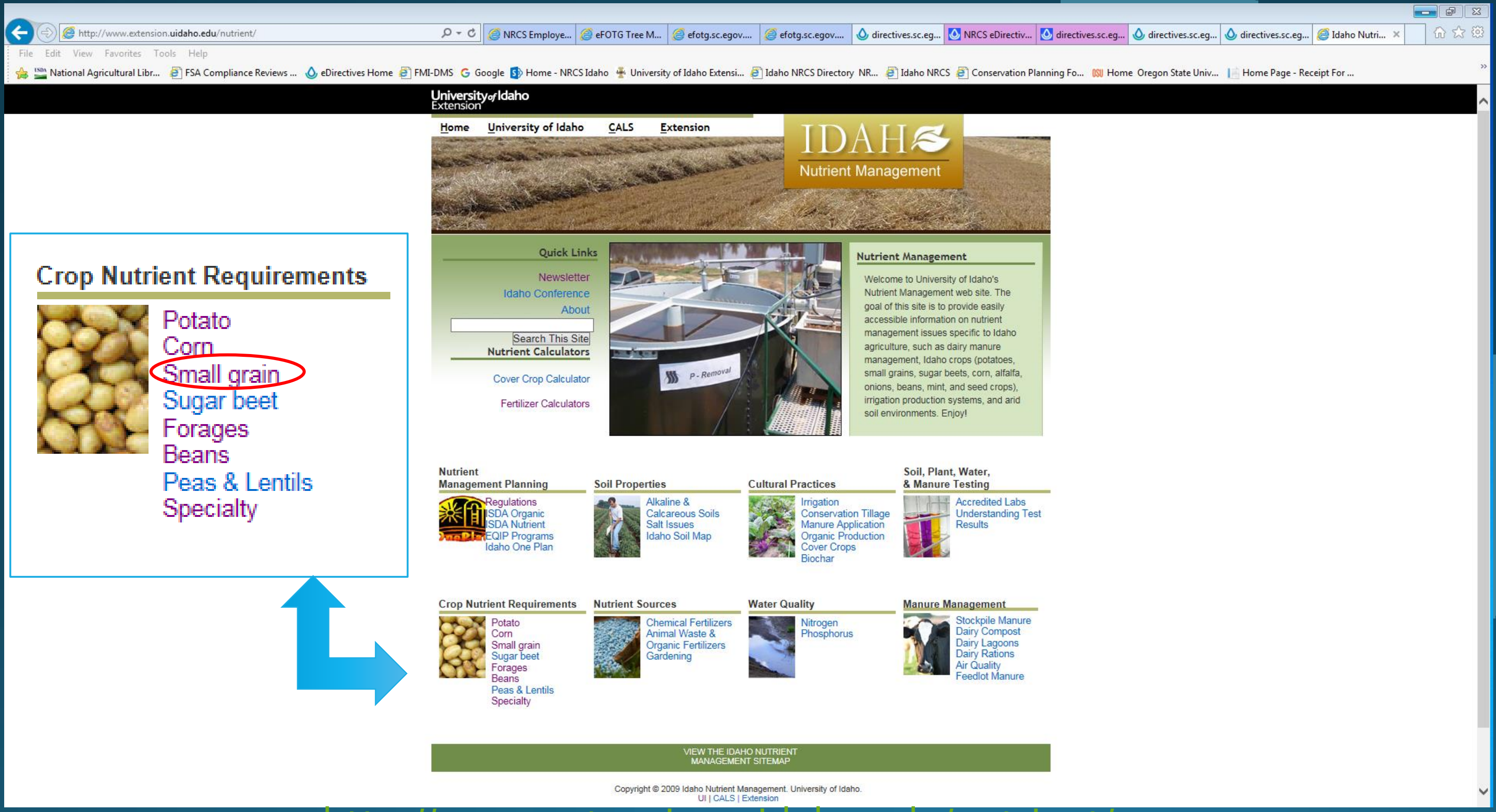
Methods: www.westernlaboratories.com/methods.htm
Remarks:

Add 40# Phosphate as starter if soil temps < 50F at planting

Split apply Nitrogen. Tissue and soil test in-season gives the best results

"Always practice the laws of Agronomy."
John P. Taberna, Soil Scientist

Step 2: Find the fertilizer guide for the crop being grown.



http://www.extension.uidaho.edu/nutrient/

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IDAHO Nutrient Management

CROP NUTRIENT REQUIREMENTS | NUTRIENT SOURCES | WATER QUALITY | ANIMAL WASTE MANAGEMENT | NUTRIENT MANAGEMENT PLANNING | SOIL PROPERTIES | CULTURAL PRACTICES

POTATO CORN SMALL GRAIN SUGARBEET FORAGES BEANS PEAS & LENTILS SPECIALTY

MANAGING NUTRIENTS FOR SMALL GRAIN PRODUCTION

Small grains are important crops throughout Idaho and are grown in diverse production systems ranging from fully irrigated to low rainfall wheat-fallow. Wheat market classes include soft white winter (SWW) and spring (SWS), hard red winter (HRW) and spring (HRS), and hard white winter (HWW) and spring (HWW), club (CW) and durum (DW). Wheat is also fed to livestock. Barley is grown for malt, animal feed, and human food. Combined small grains represent the second most valuable crop marketed in Idaho. They are valuable for the receipts they provide directly to farms but also are excellent rotation crops for other commodities that may involve higher production costs, marketing risks, and income potential. Effective nutrient management is critical for the success of small grains, affecting both production and quality. This section relates some of the information pertinent to Idaho small grain production systems

Northern Idaho Fertilizer Guide

- Spring Barley
- Winter Barley
- Soft White Spring Wheat
- Winter Wheat
- Oats

Southern Idaho Fertilizer Guide

- Irrigated Spring Barley
- Irrigated Winter Barley
- Irrigated Spring Wheat
- Irrigated Winter Wheat

Photos courtesy of International Plant Nutrition Institute (IPNI).

USDA

Southern Idaho Fertilizer Guide

Irrigated Winter Wheat

Brad Brown, Soil Scientist
Parma Research and Extension Center

The following fertilizer guidelines are based on University of Idaho research that relates the yield response of irrigated winter wheat to soil test concentrations and fertilizer application rates. The suggested fertilizer rates are designed to produce above average yields if other production factors are not limiting.

The suggested fertilizer rates also assume that soil samples are properly taken and processed, and that they represent the area to be fertilized. Many fields have appreciable variation in residual nutrients or productivity. Areas within fields that differ significantly in residual fertility or productivity should be sampled and treated separately if the areas are large enough that fertilizer application rates can be conveniently adjusted and if the treatment would be cost effective.

Precision ag technology and variable rate applicators provide options for differentially fertilizing these areas as never before. For information on mapping soil variability and variable application technology, contact an extension soil fertility specialist, your local county extension educator, or a fertilizer dealer/consultant.

Representative soil samples are essential. Each soil sample submitted to a soil test laboratory should consist of a composite of at least 20 individual cores from within the area of interest. Collect separate samples from the 0- to 12-inch and 12- to 24-inch depths. Skip areas that do not represent the majority of the field such as gravelly areas, saline or sodic areas, wet spots, and turn rows.

Do not store moist samples under warm conditions because microbial activity can change the extractable nitrogen in the sample. Send samples to the laboratory as quickly as possible if the samples are not air-dried.

Nitrogen

Adequate nitrogen (N) is necessary for maximum economic production of irrigated winter wheat. The amount of N required depends on many factors that influence irrigated winter wheat production and quality. Estimated yield and available N from all sources (soil test, previous crop, and mineralizable N) should be considered when determining N fertilizer rates.

Total N Requirements Based on Estimated Yield

Fertilizer N rates should correspond to the yield growers can reasonably expect for their soil conditions and management. Historical yields for a specific field or area provide a fair approximation of yield potential, given the grower's traditional crop management. Projected changes in crop management (water management, variety, lodging control, disease, and weed control) designed to appreciably increase production may require adjustment of estimated yield.

Research in western Idaho has shown that the available N from all sources required to produce a bushel (60 lb) of irrigated winter wheat depends on such factors as weed, insect, and disease control as well as irrigation, planting date, and soil type. Results of field trials suggest that two pounds of available N per bushel (bu) are required for irrigated winter wheat yielding up to 120 bu per acre. Nitrogen requirements are less than two pounds per bushel for yields above 120 bu per acre. The total N required for a range of expected yields is given in Table 1.

Available Nitrogen

Available N in the soil includes inorganic N as nitrate (NO_3-N) and ammonium (NH_4-N), mineraliz-

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(Revised)

Step 3: Develop a Nutrient Budget

NRCS Natural Resources Conservation Service

NUTRIENT BUDGET WORKSHEET FOR COMMERCIAL FERTILIZER ON CROPLAND

Producer: Joe Farmer | Planner: TVY | Date: 5/8/2017

ALL NUMBERS ENTERED SHOULD BE WHOLE NUMBERS (NO NEGATIVES)

Total Nutrient Needed N, P_2O_5, K_2O

Tract/ Field	Previous Crop	Current Crop	(1) Crop Yield	(2) N Needed for Crop (FG)	(3) Previous Crop N Residue Legume	(4) Previous Crop N Residue Straw (FG)	(5) N supplied from other sources (irr. Water and other misc.)	(6) Mineralized N Soil Organic Matter Credit (SOM) (FG)	(7) Soil Test N 0-12" NH4+NO3 (ppm)	(8) Soil Test N 12-24" NH4+NO3 (ppm)	(9) S = Soil Conversion Factor (weight of 1ft of soil in million lbs of soil per acre)	(10) Soil Test N Credit 0-12" [Soil Test N 0-12"x S] (Lbs-N/ac)	(11) Soil Test N Credit 12-24" [Soil Test N 12-24"x S] (Lbs-N/ac)	(12) Soil Test N Credit [0-12" + 12-24"] (Lbs-N/ac)	(13) Excess or deficient of N Needed (2) - (3) + (4) - (5) - (6) - (12) = N Recommendation	(14) Soil Test P (Method) ppm	(15) Total P_2O_5 Recommendation	(16) Soil Test K (Method) ppm	(17) Total K_2O Recommendation
Example Field	Peas	Winter Wheat	120 Bu/Ac	240	40	0	0	45	13	10	4	52	40	23*4 = 92	240-40+0-45-92 = 63	Olson 12	80	Olson 62	40
Field 1	Beans	Winter Wheat	120 Bu/Ac	240	40		0	45	20	11	4	80	44	124	31	Olsen 21	0	Olsen 350	0

Grower's Planned Nutrient Application Plan

Date	Products	Rate	Units/Ac (tons, lbs, gals, etc.)	lbs-N/Ac		lbs-P_2O_5/Ac	lbs-K_2O/Ac
					=		
					=		
					=		
					=		
					=		

What crops are best for taking up nutrients, and how to figure it out?

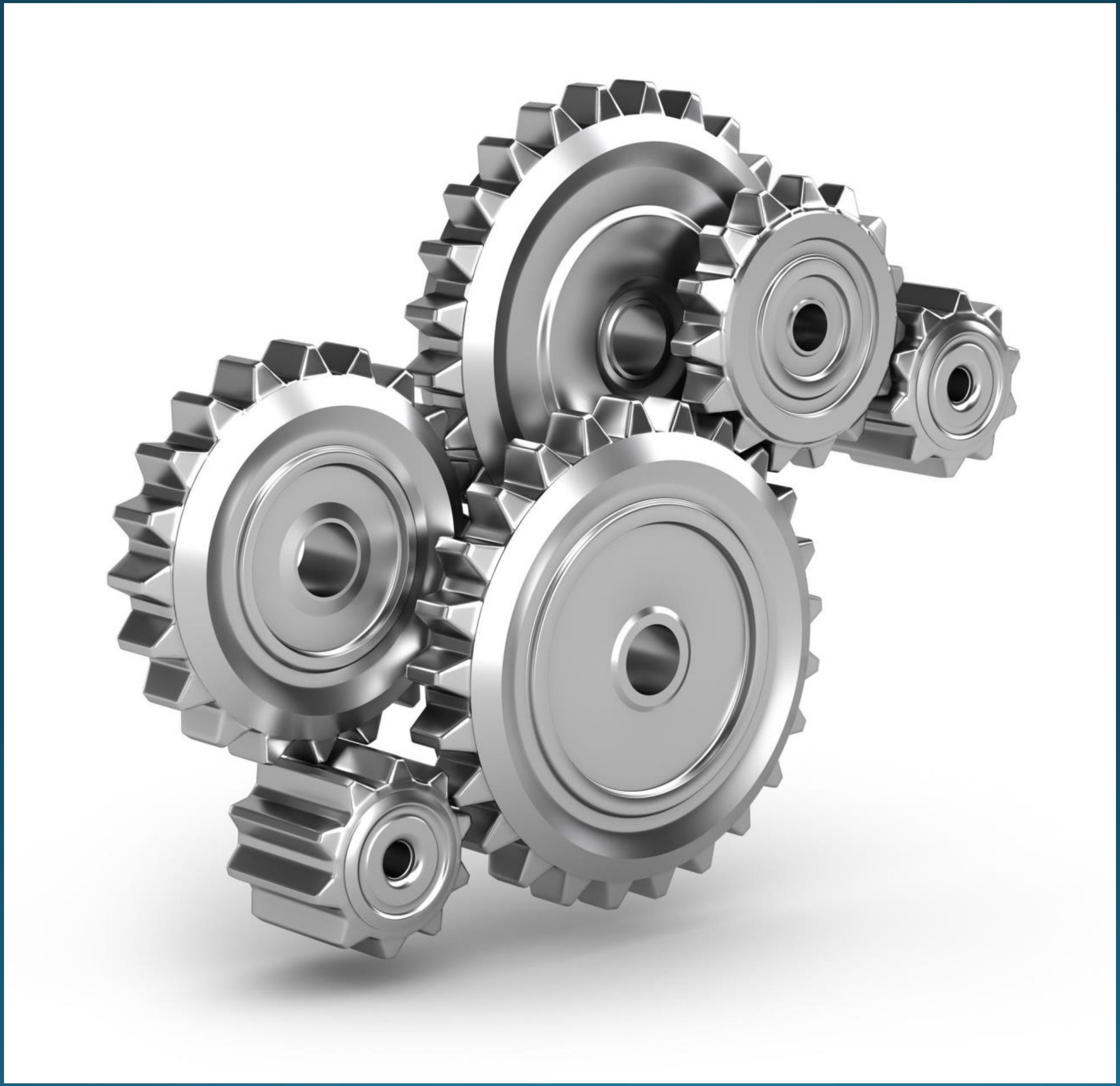
- As a general rule high producing broadleaf forage crops are good at taking up Phosphorus and Potassium. Corn or other high producing grass crops are typically high users of Nitrogen.
- IPNI (International Plant Nutrition Institute) web based nutrient removal calculator. https://www.ipni.net/app/calculator/home
- Other nutrient removal calculator applications for phones and tablets. (e.g. PlantCalc and AgPhD Fertilizer Removal tool)
- NRCS (Natural Resources Conservation Service) national plants database crop nutrient tool. https://plants.usda.gov/npk/main

Other noteworthy nutrient removal items:

- The more yield that is produced and <u>removed</u> from the field; the more nutrients get removed.

- Tissue samples can tell you how much of a nutrient are contained in plant tissues. This is useful for determining nutrient content of the growing crop prior to harvest and <u>removal</u>.
- If you don’t remove plant tissue that contains nutrients, those nutrients effectively remain in the soil and should not be accounted for as “gone” from the nutrient balance.
  - ✓ Stover, straw, grass or alfalfa not harvested, etc

United States Department of Agriculture



A little on salts and salinity

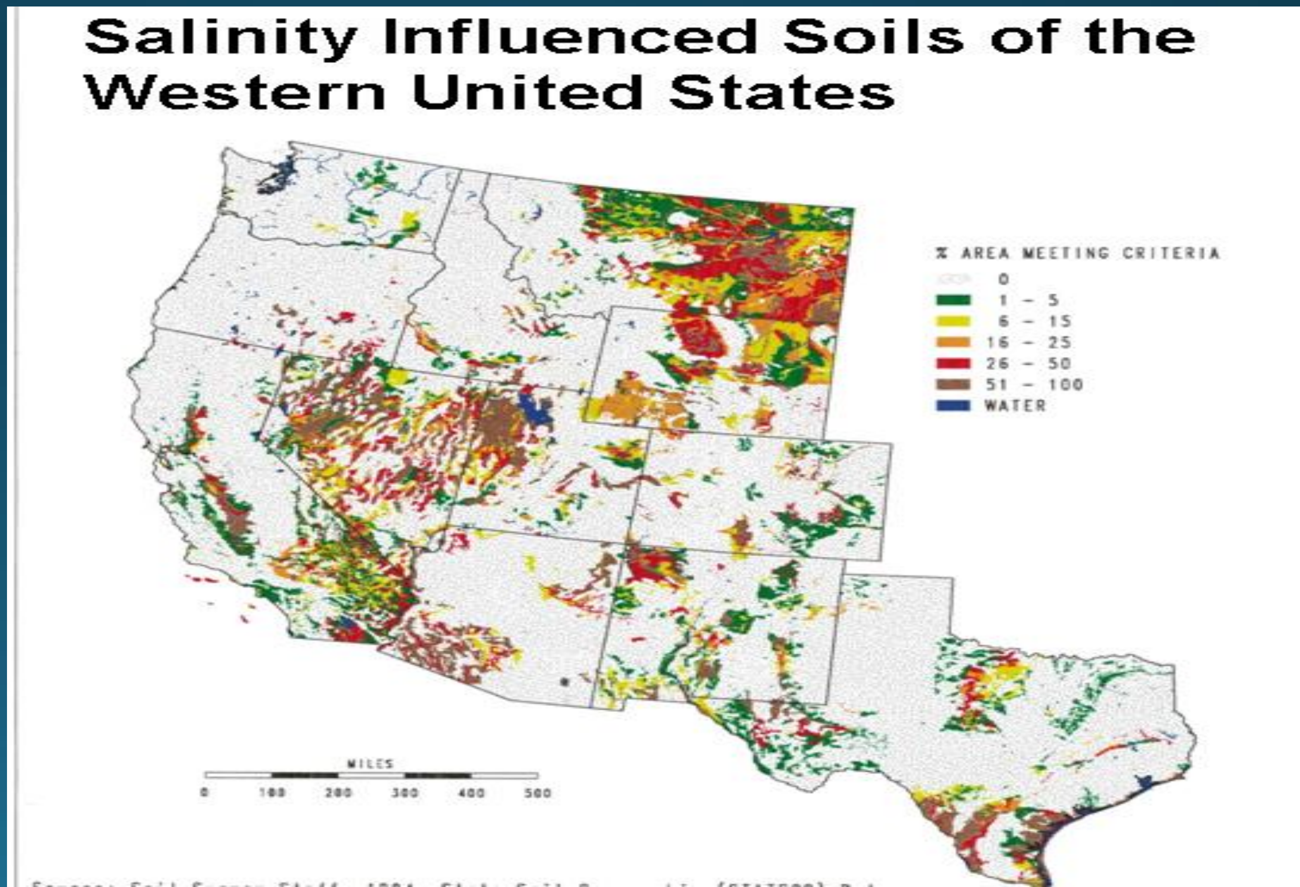
- Salinity is the saltiness or **dissolved salt content** of a body of water or soil solution.
- Salts are chemical compounds formed from the reaction of an acid with a base, that dissociate into **positively charged cations** and **negatively charged anions** in solution.

High soil salinity can lead to
- ✓ Decreased availability of soil moisture to plants
- ✓ Plant toxicity
- ✓ Reduced plant uptake of essential nutrients
- ✓ Negative impacts to soil structure, which leads to reduced infiltration capacity and permeability

A little on salts and salinity

- As a farmer in Eastern Idaho I basically didn’t think about it since there is “good” geology/soils and good water quality
- With NRCS in Idaho, we don’t often think about it, but there are some locations where geology and water quality pose a danger

My NRCS experience has been related to effects on infiltration rather than on other presentations of salts and salinity problems



Goal of Water Management for Salinity

- to **maintain** the salinity within limits that neither allow excess drainage nor reduce crop growth.

in & out

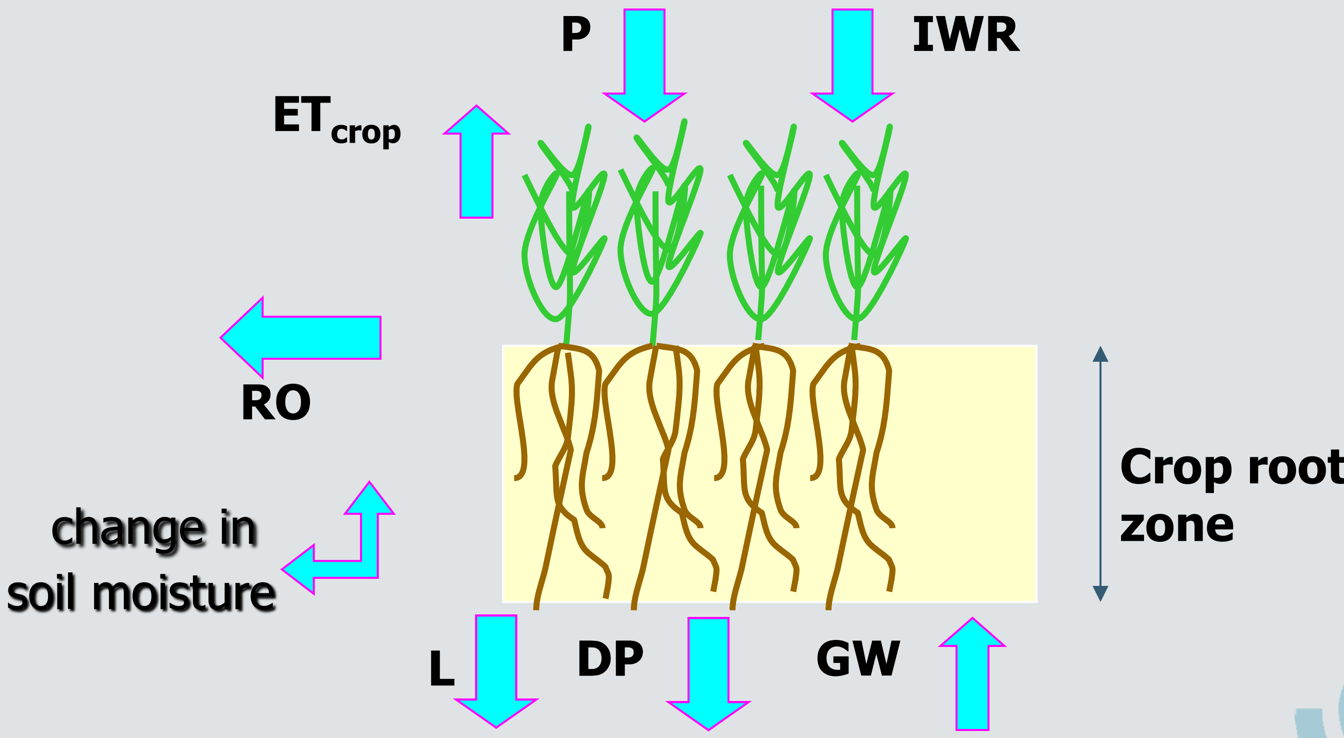
Going in

- Precipitation
- Ground water
- Irrigation Water Requirement

Going out

- Evapotranspiration
- Runoff
- Deep Percolation
- Leaching Requirement

$$IWR = ET_{crop} + DP + RO - P \pm \Delta SW - GW + L$$

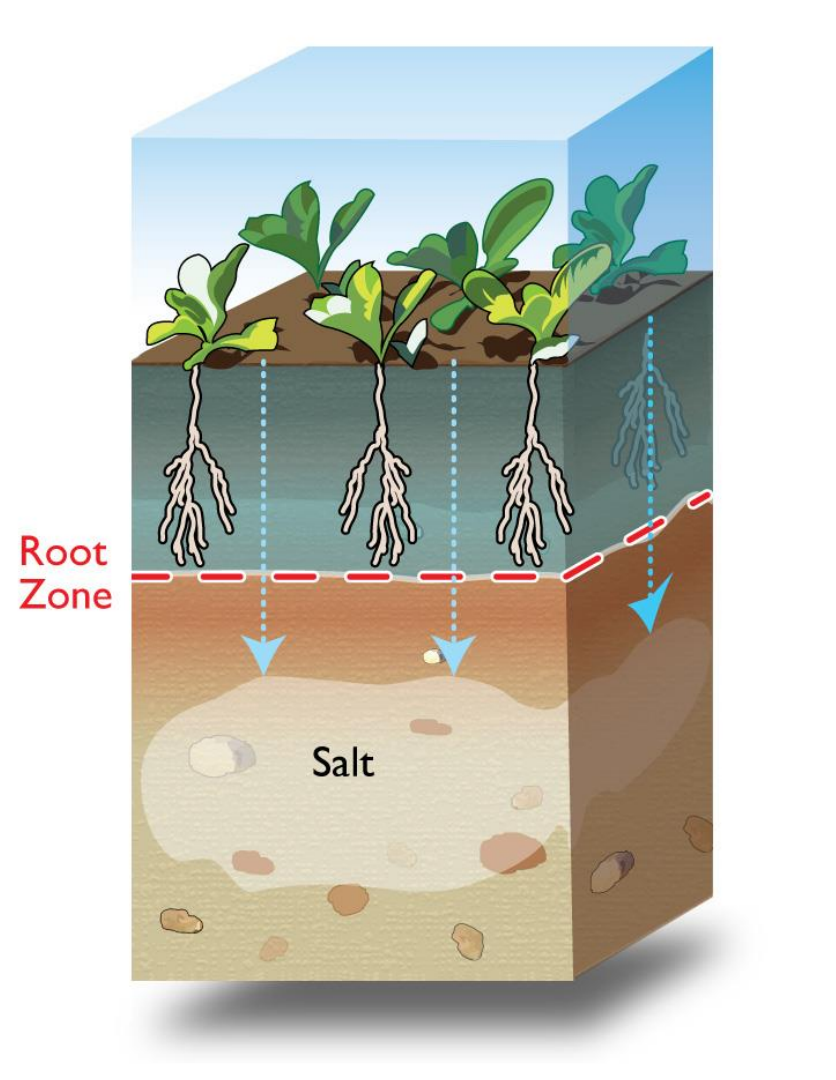


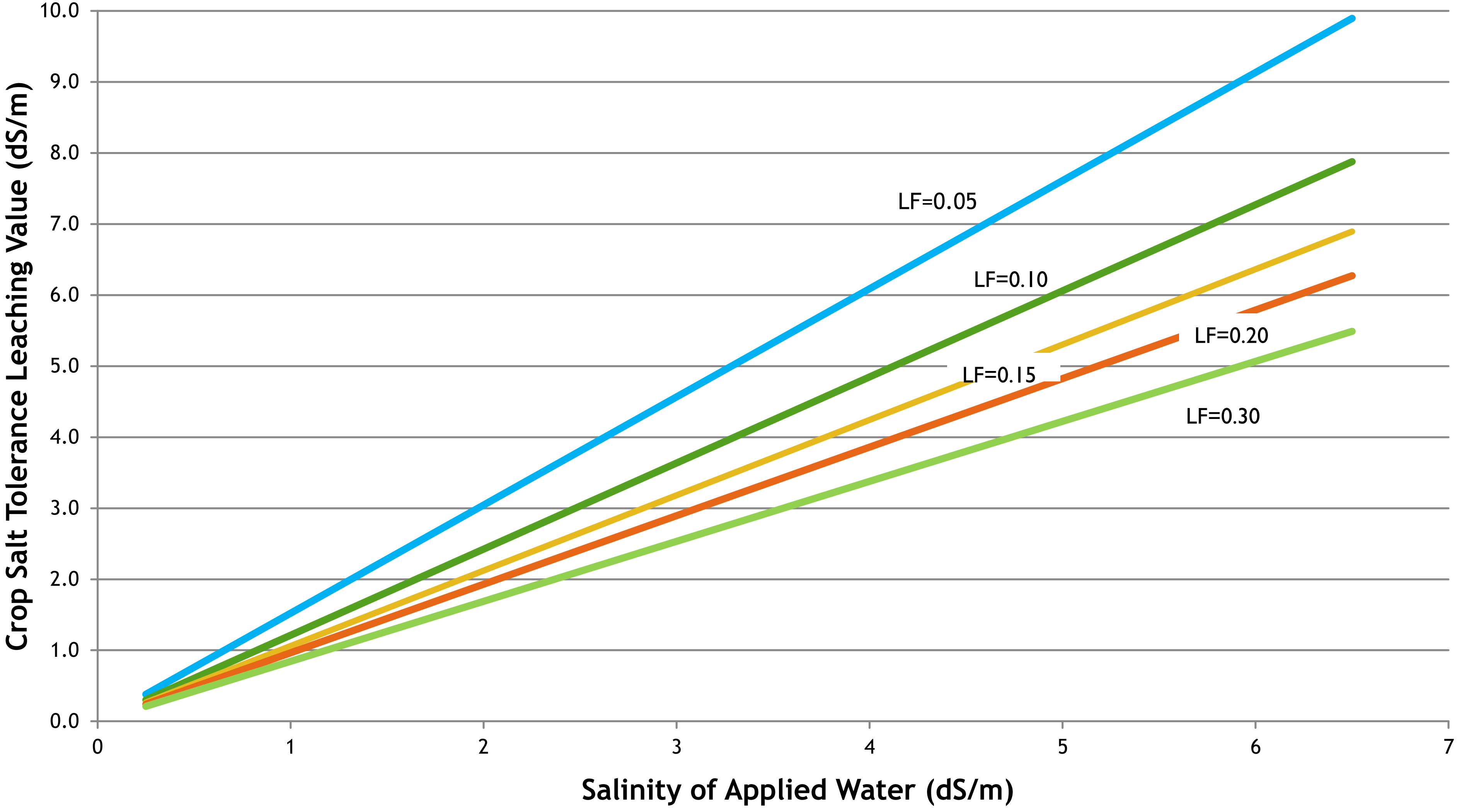
Leaching fraction (L_f)

- The ratio of the depth of drainage water, or deep percolation through the root zone, to the depth of infiltrated water

Leaching Requirement

- The depth of water passing through the root zone needed to prevent yield reduction
- Think of it as intentional deep percolation





Crop Salt Tolerance Leaching Value (dS/m)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6
7
Salinity of Applied Water (dS/m)
LF=0.05
LF=0.10
LF=0.15
LF=0.20
LF=0.30

United States
Department of
Agriculture

Some common salt tolerant crops

- barley
- wheatgrass
- bermudagrass
- sugar beets
- sorghum
- wheat

Table 13–3 Salt tolerance of selected crops [1]

Common name	Botanical name	Salt tolerance threshold [2] (EC_t)	Yield decline [3] (Y_d)	Qualitative salt tolerance rating [4]
		mmho/cm	% per mmho/cm	
Field crops				
Barley	*Hordeum vulgare*	8.0	5.0	T
Bean	*Phaseolus vulgaris*	1.0	19	S
Broad bean	*Vicia faba*	1.6	9.6	MS
Corn	*Zea Mays*	1.7	12	MS
Cotton	*Gossypium hirsutum*	7.7	5.2	T
Cowpea	*Vigna unguiculata*	4.9	12	MT
Flax	*Linum usitatissimum*	1.7	12	MS
Guar	*Cyamopsis tetragonoloba*	8.8	17.0	T
Millet, foxtail	*Setaria italica*	—	—	MS
Oats	*Avena sativa*	—	—	MT
Peanut	*Arachis hypogaea*	3.2	29	MS
Rice, paddy [5]	*Oryza sativa*	3.0	12	S
Rye	*Secale cereale*	11.4	10.8	T
Safflower	*Carthamus tinctorius*	—	—	MT
Sesame	*Sesamum indicum*	—	—	S
Sorghum	*Sorghum bicolor*	6.8	16	MT
Soybean	*Glycine max*	5.0	20	MT
Sugar beet	*Beta vulgaris*	7.0	5.9	T
Sugarcane	*Saccharum officinarum*	1.7	5.9	MS
Sunflower	*Helianthus annuus*	—	—	MS
Triticale	*x Triticosecale*	6.1	2.5	T
Wheat	*Triticum aestivum*	6.0	7.1	MT
Wheat (semidwarf)	*T. aestivum*	8.6	3.0	T
Wheat, durum	*T. turgidum*	5.9	3.8	T
Grasses and forage crops				
Alfalfa	*Medicago sativa*	2.0	7.3	MS
Alkaligrass, nuttall	*Puccinellia airoides*	—	—	T
Alkali sacaton	*Sporobolus airoides*	—	—	T
Barley (forage)	*Hordeum vulgare*	6.0	7.1	MT
Bentgrass	*Agrostis stolonifera palustris*	—	—	MS
Bermudagrass	*Cynodon dactylon*	6.9	6.4	T
Bluestem, angleton	*Dichanthium aristatum*	—	—	MS
Brome, mountain	*Bromus marginatus*	—	—	MT
Brome, smooth	*B. inermis*	—	—	MS
Buffelgrass	*Cenchrus ciliaris*	—	—	MS
Burnet	*Poterium sanguisorba*	—	—	MS
Canarygrass, reed	*Phalaris arundinacea*	—	—	MT

USDA United States Department of Agriculture

Discussion……then I'm back to the Big Water